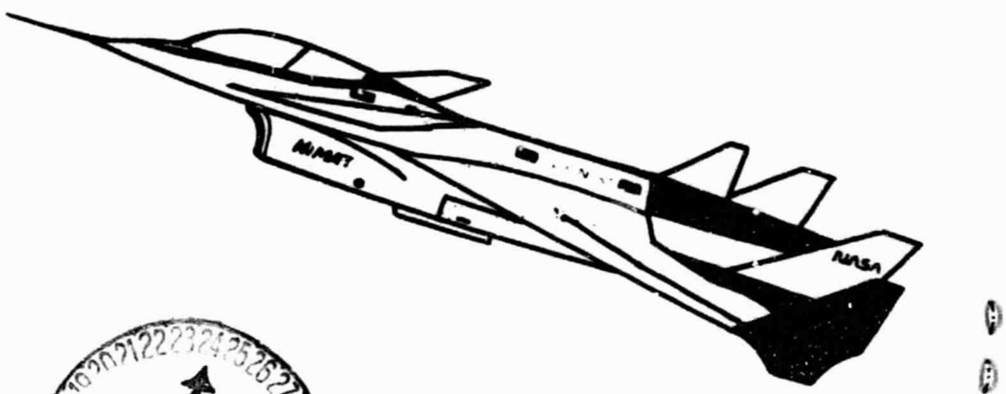
Aeronautics Research and Technology Program and Specific Objectives



Office of Aeronautics and Space Technology

Fiscal Year 1983

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NASA
National Aeronautics and Space Administration

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

AERONAUTICS RESEARCH AND TECHNOLOGY PROGRAM

PROGRAM AND SPECIFIC OBJECTIVES
DOCUMENT APPROVAL

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6/13/82
Date

PREFACE

The Office of Aeronautics and Space Technology (OAST) is responsibile for planning and managing NASA's Aeronautics and Space Research and Technology programs and Energy* Technology programs. Broad goals have been established for these programs to assure that they are aligned toward providing the technology required to meet national needs in aviation, space and energy.

The OAST Program and Specific Objectives documents set forth a much more detailed set of objectives (that derive from these broad program goals) which form the basis for planning specific research and technology activities. Separate Program and Specific Objectives documents have been developed for the Aeronautical and Space Research and Technology programs.

The Program and Specific Objectives documents are intended to meet the following management goals:

- o To effectively communicate and describe the OAST programs;
- o To provide management with an integrated viewpoint of an inherently complex and multifaceted R&T program, thereby facilitating the decision process;
- o To force a disciplined approach on near-term detailed planning;
- o To provide a framework from which an orderly evolution of the program can be planned;
- o To facilitate evaluation of the technical feasibility of programs, and to facilitate judgment of the adequacy of our planning;
- o To make the program more result- and accomplishment-oriented;
- o To improve program control by providing each level of management with a clear set of objectives and targets to be accomplished, as well as a set of standards against which progress can be measured;

* Current Energy program is "Reimbursable" only.

- To make individual researchers/technologists aware of the significance of their output to broad objectives, goals and needs, and to stimulate their imaginations with challenging targets; and
- To provide a vehicle for implementing the program via solicitation of Research and Technology Objectives and Plans (RTOP) documents from the NASA Field Installations, while allowing the Field Installations maximum flexibility in developing innovative RTOP approaches toward meeting stated objectives and targets.

  (The RTOP is the vehicle by which an agreement or contract is reached between OAST and a Field Installation concerning the performance and funding of a specific research and technology activity.)

These documents are tools which should be utilized by everyone engaged in planning, managing and performing the OAST programs, to insure that they are fully aware of the purpose of their efforts. It is important, therefore, that these documents, or appropriate parts thereof, be distributed to all levels of the NASA organization involved in the OAST programs.

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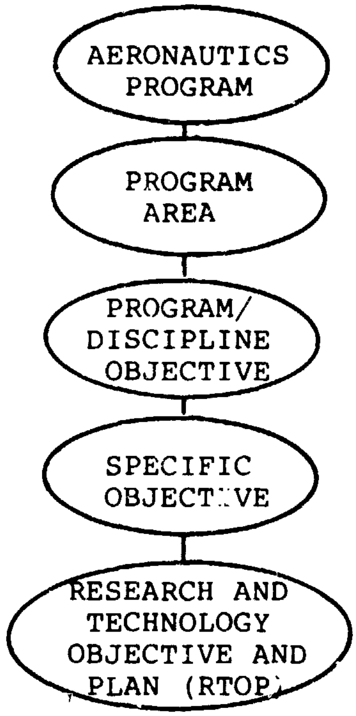
INTRODUCTION

INTRODUCTION

The Aeronautics Research and Technology program is broken down into two Program Areas:

- o Research and Technology Base
- o Systems Technology Programs

which are further broken down into succeedingly more detailed activities to form a Work Breakdown Structure for the Aeronautics program, as shown in the following chart.



This document provides a detailed view of this Work Breakdown Structure down to the Specific Objective level, and sets forth goals or objectives at each of these levels. It addresses what is to be accomplished and why, but does not address how. The latter falls within the domain of the RTOP, as well as other program documents.

The nature of the Aeronautics program is advanced research and technology. The input to the program is the capable effort of highly qualified people, using specialized equipment and facilities, doing theoretical, analytical and experimental work. The output is new technical knowledge. This output is created by OAST primarily for application by the aviation industry and the military. Further, the program is highly synergistic, with a given piece of new technology finding broad application by different users to meet different needs. This multiple applicability aspect of the output is fundamental to the structure and management of the Aeronautics program.

The Aeronautics Program and Specific Objectives document provides goals, objectives and targets in sufficient detail to provide a structure within which Field Installations (Centers) can make decisions concerning RTOP planning and implementation. It is expected that each Center develop and propose a set of RTOP's which fully responds to the objectives and targets set forth in this document, limited only by the roles assigned to that Center by the Agency.

In this document, the Specific Objective narratives provide the lowest level documentation of the program's objectives, and therefore the most detailed. Each RTOP, at a Center, is developed to address a single Specific Objective. The Specific Objective narratives are structured into several parts. First, a short paragraph statement of the Specific Objective is given. This is followed by a bulleted list of thrusts or sub-objectives which delineate the scope of the Specific Objective. A list of targets is then provided for those areas of the Specific Objective that are amenable to a quantitative description of technical accomplishment and schedule. It is important that an RTOP prepared in response to a given Specific Objective address both the thrusts and targets. Finally, a justification statement is included which establishes the need and importance of the Specific Objective.

The targets have been selected to be challenging, but realistic. They may not all be accomplished within the specified time frame. The research and technology process is characterized by an unpredictable path that can result in failure. However, it is recognized that the researchers/technologists are at their best when they are seriously committed to achieving a set of targets.

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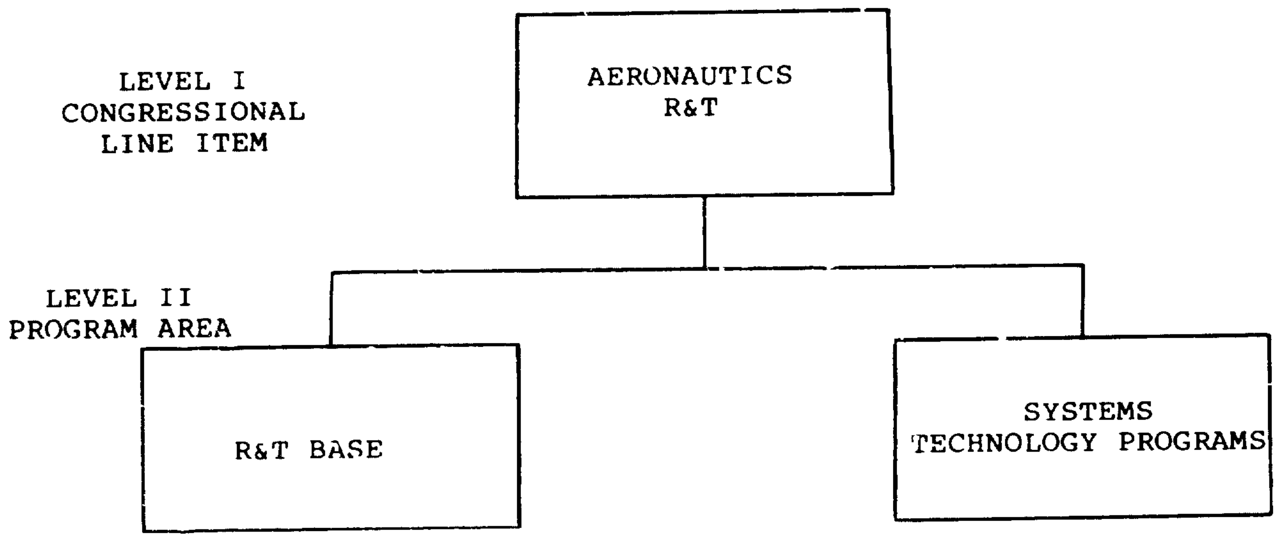
AERONAUTICS RESEARCH AND TECHNOLOGY

AERONAUTICS R&T WORK BREAKDOWN STRUCTURE, LEVELS I & II



PROGRAM GOAL

TITLE: Aeronautics Research and Technology

PROGRAM GOAL:

To advance aeronautics technology to make possible safer, more economical, efficient, and environmentally acceptable air transportation systems which are responsive to current and projected national needs; to support the military in maintaining the superiority of the nation's military aircraft; and to maintain the strong competitive position of the United States in the international aviation marketplace. The program is directed at advancing technology to maintain a solid foundation of aeronautical technology in all relevant disciplines and areas of systems research to meet future needs of both military and civil aviation and to support the military by providing an advanced technology base which may be uniquely applicable to military aircraft, or applicable as well to civil aircraft, and by providing technical problem-solving support for current military aircraft development.

PROGRAM AREA GOALS:

- Research and Technology Base: To establish and maintain a solid foundation of aeronautical technology embracing all of the relevant disciplines and areas of systems research and to provide a wellspring of ideas for advanced aeronautical concepts.

- Systems Technology Programs: To provide technology for systems which have matured under the Research and Technology Base; to carry innovative systems through experimental testing and verification in a realistic environment; to design, fabricate and test multidisciplinary concepts, thereby greatly reducing the technical and development risks and decreasing the excessive time lag between technology development and its application; and to design and fabricate major aeronautical research vehicles which serve as testbeds for evaluating innovative subsystem concepts.

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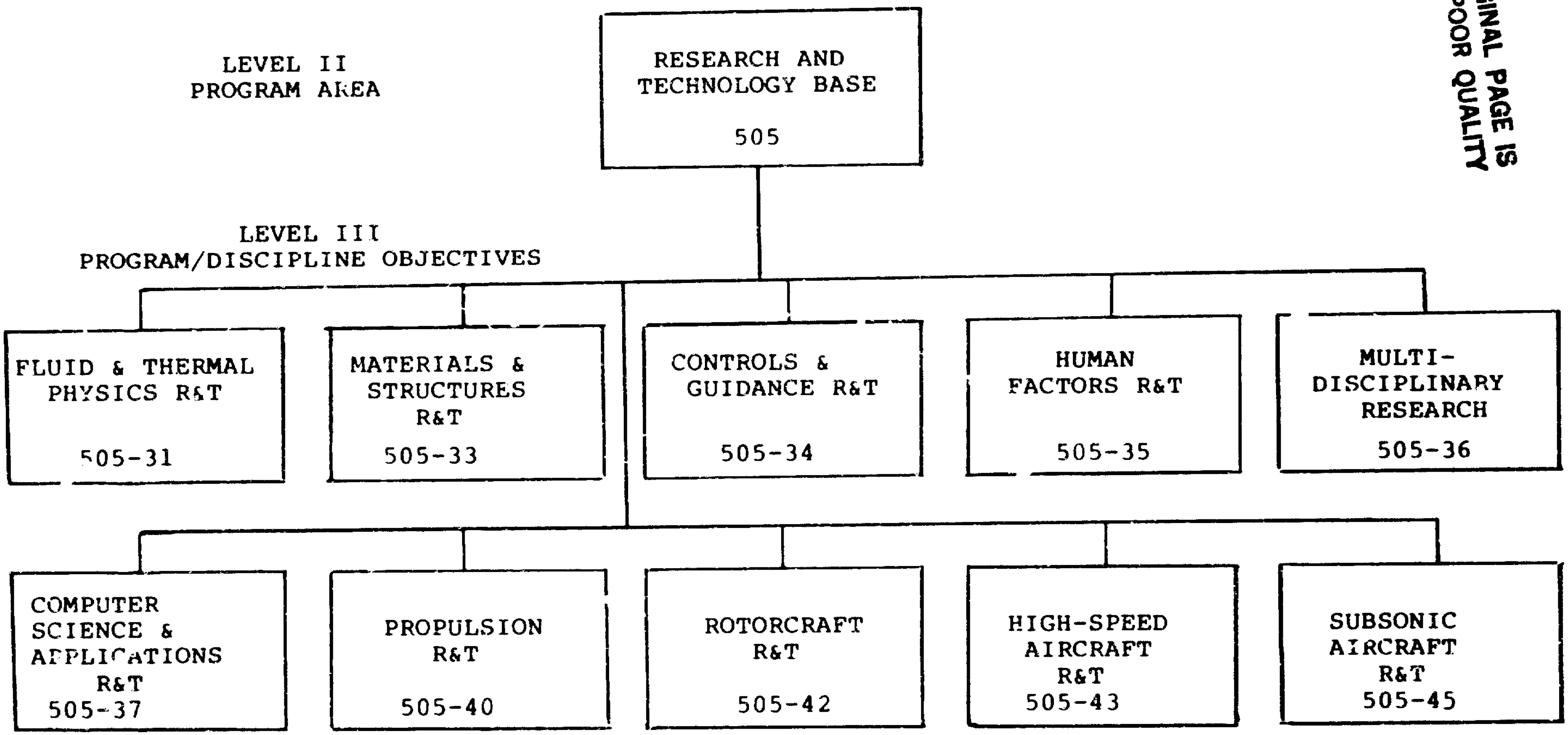
RESEARCH AND TECHNOLOGY BASE

AERONAUTICS R&T BASE WORK BREAKDOWN STRUCTURE
LEVELS II & III



PROGRAM AREA GOAL

TITLE: Research and Technology Base

Program Goal Title: Aeronautics Research and Technology

PROGRAM AREA GOAL:

To establish and maintain a solid foundation of aeronautical technology embracing all of the relevant disciplines and areas of systems research associated with aeronautics and to provide a well-spring of ideas for advanced concepts.

PROGRAM/DISCIPLINE OBJECTIVES:

- Fluid and Thermal Physics R&T: To advance the understanding and predictive capability of aerodynamic phenomena to permit aerodynamic optimization of advanced aircraft missiles and their turbomachinery in early design stages.

- Materials and Structures R&T: To provide a materials and structures technology that will permit the aerospace industry to develop new and improved, safe and reliable metals, polymers, and ceramics and the application of these materials to advanced structures that will result in significant improvements in the performance, safety, durability, and economy of commercial, military and general aviation aircraft.

- Controls and Guidance R&T: To develop advanced controls and guidance theory concepts and design technology to improve performance, operating efficiency and mission effectiveness of civil and military aircraft in the late 1980's and the 1990's.

- Human Factors R&T: To provide the research and technology base for solutions to the human problems impeding the growth or safety of air transportation.

- Multidisciplinary Research: To conduct basic research of a multidisciplinary nature related to the field of aeronautics technology.

- Computer Science and Applications R&T: To provide an agency foundation in fundamental computer science through research and experimentation, and to facilitate the infusion of state-of-the-art computer science and technology into aerospace applications. To provide the theoretical and technology base needed to develop advanced aerospace computing concepts and to evolve advanced system architectures in response to unique aerospace requirements. To improve the development process and the quality of aerospace-related systems and software. To provide advanced theory, concepts, techniques, and capabilities for the effective use and management of aerospace information. To provide state-of-the-art computational facilities for the conduct of research in computer science and technology for aerospace applications.

- Propulsion R&T: To provide, through applied technology and experimental evaluation, the knowledge, understanding, and technology base necessary to achieve safer and more energy efficient, economical, reliable and environmentally acceptable propulsion systems for future aircraft of all types, ranging from small general aviation aircraft and helicopters to commercial transports and military aircraft.

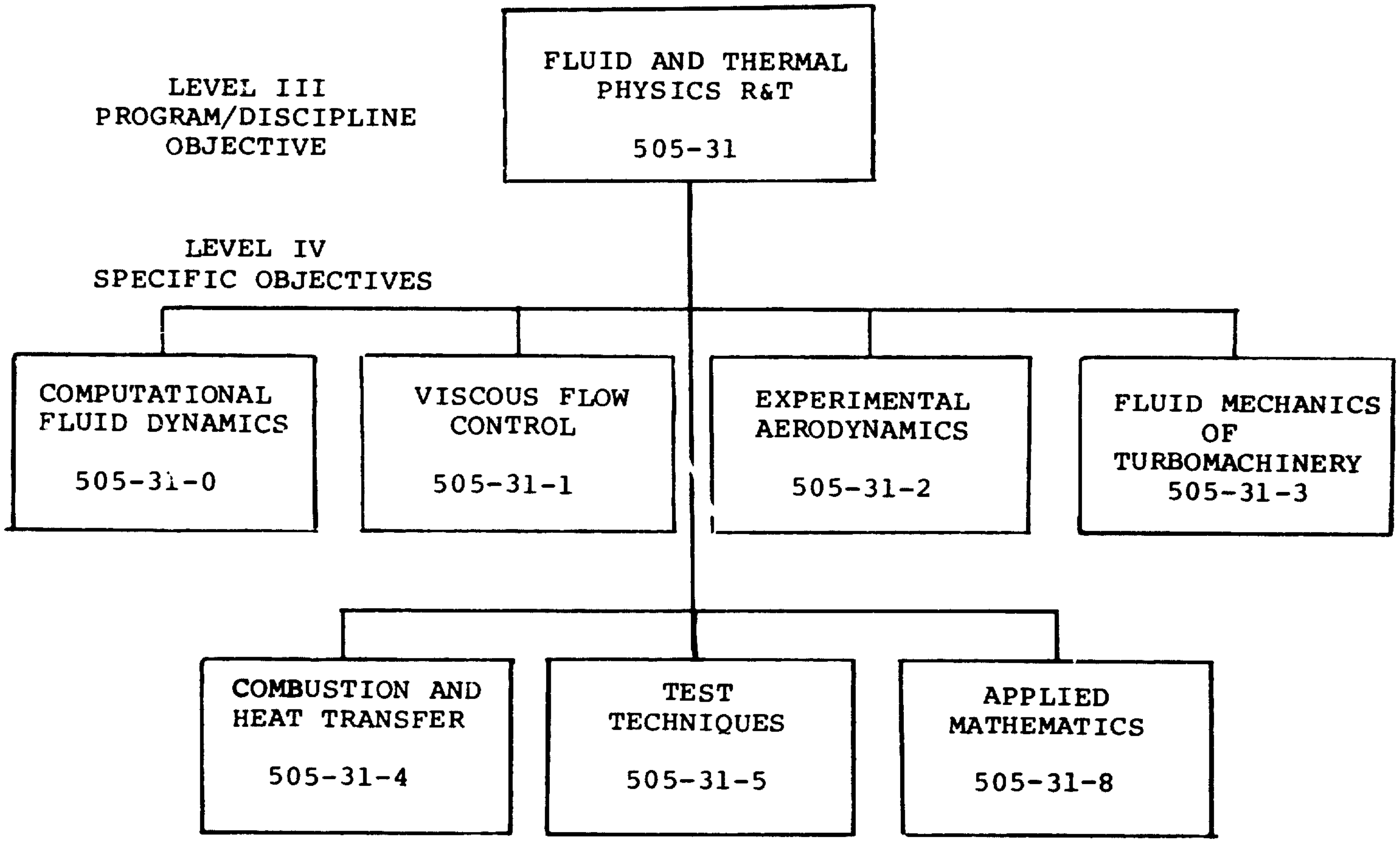
- Rotorcraft R&T: To provide, through state-of-the-art advances, improvements in technology areas of rotorcraft structures, dynamics, aerodynamics, acoustics, flight dynamics, controls, avionics, and man-system integration which will provide a technology base for future advances in military and civil rotorcraft vehicles.

- High-Speed Aircraft R&T: To evolve and explore advanced concepts for future high-speed aircraft, generate improved analytical prediction methods and experimental data for DOD/industry use, and directly support DOD and other Government agencies.

- Subsonic Aircraft R&T: To provide, in the general area of subsonic aircraft, the necessary systems research and concept development to provide an improved and validated base of new technology for application by industry to future generations of the entire spectrum of civil/military aircraft.

FLUID & THERMAL PHYSICS R&T

FLUID AND THERMAL PHYSICS R&T WORK BREAKDOWN STRUCTURE
LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Fluid and Thermal Physics R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aerospace Research Division/Clinton E. Brown

PROGRAM/DISCIPLINE OBJECTIVE:

To advance the understanding and predictive capability of aerodynamic phenomena to permit aerodynamic optimization of advanced aircraft, missiles and their turbomachinery in early design stages.

SPECIFIC OBJECTIVES:

- o Computational Fluid Dynamics: To develop the computational analyses required to investigate and understand basic fluid dynamic flow phenomena and to use the analyses to provide the capability for calculating across a broad spectrum the characterizations of both steady and unsteady, internal and external flows.

- o Viscous Flow Control: To acquire experimental data for complex turbulent flows and develop corresponding turbulence math models, to develop 3-D laminar stability and boundary-layer transition prediction techniques and to explore and develop turbulent skin friction drag reduction devices, and to develop a quiet supersonic wind-tunnel test section and predict and reduce airframe aerodynamic noise.

- o Experimental Aerodynamics: To provide the fundamental data base needed for the efficient design of advanced aircraft and for the development of aerodynamic prediction techniques.

- o Fluid Mechanics of Turbomachinery: To develop a fundamental understanding of steady and unsteady flow physics for generation of flow models and code verification, and to minimize the unsteady aerodynamic airloads and noise generation in advanced turbomachinery.

- o Combustion and Heat Transfer: To establish a more complete and basic understanding of fundamental combustion and heat transfer phenomena typical of gas turbine engines and to support the development of advanced computational techniques for accurately characterizing the governing aerothermodynamic processes.

- Test Techniques: To provide the technology for increased experimental research capability required to improve the measurement and prediction of aerodynamic and propulsion performance of current and advanced aircraft and missile designs.

- Applied Mathematics: To provide new mathematical methods and models and apply these to understanding aerospace phenomena, improving computer simulation and supporting advanced developments.

SPECIFIC OBJECTIVE

TITLE: Computational Fluid Dynamics

Program/Discipline Objective Title: Fluid & Thermal Physics R&T

Responsible Organization/Individual: Aerospace Research Division/Randolph A. Graves, Jr.

SPECIFIC OBJECTIVE:

To develop the computational analyses required to investigate and understand basic fluid dynamic flow phenomena and to use the analyses to provide the capability for calculating across a broad spectrum the characteristics of both steady and unsteady, internal and external flows.

- o Develop effective methods for solving the fluid flow equations with emphasis on improving computational efficiency through construction of new algorithms, improving computer languages, improving geometric modeling, and advancing solution and component adaptive grid generation techniques.
- o Develop the computational procedures needed to investigate and analyze across the full speed range the flow interactions common to all classes of aircraft and propulsion systems.
- o Determine the ranges of applicability and accuracy of the analyses and provide guidance for improving these analyses by conducting suitable experiments, performing companion calculations, and comparing results.
- o Demonstrate use of new technology by applying analyses to selected problems of interest to the aerospace industry and Department of Defense.

TARGETS:

- o Improve the efficiency of the algorithms used for the solution of 3-D viscous flows in FY 1983.
- o Improve the large eddy and vortex filament computational analyses required to simulate the development and propagation of turbulent flows in FY 1983.

- o Develop improved unsteady inviscid flow analyses by the end of FY 1984.
- o Improve the methods for generating meshes about complicated 2- and 3-D surfaces in FY 1984.
- o Improve the transonic flow analyses for wings/bodies/pylons/nacelles with both turboprop and turbofan propulsion systems in FY 1984.
- o Develop automatic numerical optimization techniques for drag minimization of wings, blended wing/bodies, and turbofan blades in FY 1984.
- o Develop 3-D adaptive grid generation methods with emphasis on global error and mesh point minimization by FY 1985.
- o Develop improved unsteady viscous flow methods for analyzing flows both through turbofan blade rows and over transonic wings with control surfaces by FY 1985.
- o Develop numerical optimization methods for compressor and turbine blade design in FY 1985.

JUSTIFICATION:

The amount of experimental test time required to develop new aircraft and advanced propulsion systems has increased rapidly when measured in terms of test hours. Costs of conducting these experimental flow simulations have increased correspondingly. On the other hand, the cost of simulating a given flow mathematically on the computer has been decreasing rapidly, since computer technology growth has increased computer speed more rapidly than computer cost. Therefore, large-scale computers can complement experimental facilities and more efficiently simulate certain types of flows, thereby providing an advanced tool for rapidly analyzing and optimizing new designs and for containing development costs. Moreover, large-scale computation with advanced computers will allow detailed investigation of basic fluid dynamic phenomena, as well as simulation of flows, that are highly impractical or impossible to simulate in experimental facilities.

SPECIFIC OBJECTIVE

TITLE: Viscous Flow Control

Program/Discipline Objective Title: Fluid and Thermal Physics R&T

Responsible Organization/Individual: Aerospace Research Division/Gary Hicks

SPECIFIC OBJECTIVE:

To acquire experimental data for complex turbulent flows and develop corresponding turbulence math models, to develop 3-D laminar stability and boundary-layer transition prediction techniques and to explore and develop turbulent skin friction drag reduction devices; to develop a quiet supersonic wind-tunnel test section and predict and reduce airframe aerodynamic noise.

- Explore techniques for turbulent skin friction drag reduction to include surface modifications, convex curvature, and ion wind concepts.
- Develop a rational method for predicting boundary-layer transition, resolving the problems of receptivity, nonlinear wave development, and wave packet instability.
- Develop technology for quiet supersonic wind tunnels to provide for meaningful supersonic boundary-layer transition research.
- Obtain detailed experimental data to enhance the understanding of turbulence physics and to derive turbulence models.
- Conduct fundamental research into the generation of noise by turbulent aerodynamic flows impinging on aircraft surfaces.

TARGETS:

- Complete research for detailed design of a supersonic quiet tunnel utilizing the recent discovery of a quiet test core due to rapid expansion nozzle by end of FY 1983.
- Verify turbulence model for separated flow on transonic airfoils by end of FY 1983.

- o Determine whether small longitudinal surface grooves and large porosity turbulence fences can be optimized to produce a net drag reduction of 15 percent by end of FY 1983.

- o Develop methodology and study basic physics, generation, and growth of disturbances including detailed measurement of spatial growth for theory validation by end of FY 1984.

- o Determine the feasibility of the convex curvature concept of turbulent drag reduction and assess its applicability to supersonic flows by FY 1984.

- o Conduct numerical and experimental studies of shock wave/turbulence interaction emphasizing vorticity amplification and spectra distortion across shocks by end of FY 1984.

- o Conduct flight tests of turbulent drag reduction device when a 15 percent overall drag reduction has been achieved at high Reynolds numbers in wind tunnel tests by FY 1986.

JUSTIFICATION:

The understanding of turbulence is the pacing item in aerodynamic analysis and is generally recognized as the primary unsolved problem in that field. Because of its importance in prediction methodology and the fact that no practical theory exists, a large data base is required to provide information to develop simple engineering models of turbulent flows. Turbulent skin friction drag is the largest single source of drag on long-range aircraft. Controlling the boundary-layer transition and reducing the turbulent skin friction drag will reduce fuel consumption for all classes of aircraft. Viscous flows also influence aircraft maximum lift coefficient, aerodynamic heating, infrared signature and combustor efficiency.

SPECIFIC OBJECTIVE

TITLE: Experimental Aerodynamics

Program/Discipline Objective Title: Fluid and Thermal Physics R&T

Responsible Organization/Individual: Aerospace Research Division/Gary Hicks

SPECIFIC OBJECTIVE:

To provide the fundamental data base needed for the efficient design of advanced aircraft and for the development of aerodynamic prediction techniques.

- o Generate experimental and analytical procedures to advance the understanding of airfoils for fixed- and rotary-wing aircraft.
- o Explore the aerodynamic phenomena associated with the interaction of airframe components.
- o Perform fundamental tests and analyses in high-speed flow to derive efficient aerodynamic design procedures for supersonic/hypersonic vehicles.
- o Improve the understanding of aircraft wake vortex flows through fundamental flow measurements and advanced computational techniques.
- o Perform flight tests of fundamental aerodynamic phenomena in support of wind-tunnel and theoretical studies.

TARGETS:

- o Demonstrate feasibility of extending PANAIR to 3-D transonics and convert code to Cray computer by end of FY 1983.
- o Complete high-alpha testing and analysis of cones, ogive cylinders and noncircular cross-section bodies by end of FY 1983.
- o Experimentally determine near-field characteristics of unalleviated and alleviated wake vortices by end of FY 1983.
- o Demonstrate application of free vortex sheet theory to design optimization of slender transonic maneuvering aircraft configurations - FY 1983.

- o Develop three-dimensional flow-field analysis techniques for wing-body configurations, as well as for inlet and nozzle exhaust flow fields for supersonic/hypersonic vehicles by FY 1984.

- o Incorporate nonlinear effects and leading-edge thrust into an experimentally verified supersonic wing design procedure - FY 1984.

- o Complete development and validation of far-field wake vortex codes by end of FY 1984.

- o Perform detailed flow-field measurements near high-lift wings to define initial wake vortex shedding and beginning of vortex wake rollup - FY 1984.

- o Develop and validate experimentally an aircraft wing-body optimization code by FY 1984.

- o Develop and test high-lift airfoil systems at full-scale Reynolds numbers for commercial and military aircraft by end of FY 1985.

JUSTIFICATION:

The increased performance requirements of modern aircraft combined with severe economic factors place extreme importance on good design and performance prediction methodology. NASA's strong position in advanced aerodynamic technology is due in large part to its strong program in experimental aerodynamics. The task of determining optimal geometries for wing sections and combinations of aircraft components is a vital part of design.

Supersonic/hypersonic aircraft with long-range capability and low sonic boom levels have the potential of providing a major step in transportation in the latter part of the century, a strike or reconnaissance mission for the military, and a low-cost space logistics system.

The persistent nature of trailing vortices generated by jet transports creates a documented safety hazard for following aircraft. Unless the wake vortex hazard is minimized, it will continue to set the minimum separation distances and severely curtail optimum use of the nation's airports.

SPECIFIC OBJECTIVE

TITLE: Fluid Mechanics of Turbomachinery

Program/Discipline Objective Title: Fluid and Thermal Physics R&T

Responsible Organization/Individual: Aerospace Research Division/Stephen Wander

SPECIFIC OBJECTIVE:

To develop a fundamental understanding of steady and unsteady flow physics for generation of flow models and code verification, and to minimize the unsteady aerodynamic airloads and noise generation in advanced turbomachinery.

- o Fundamental Experiments - Conduct detailed experiments to obtain data in critical flow regions and to provide systematic study of geometry effects utilizing simple geometry flow passages, cascades, wind tunnels, and large low-speed rigs.
- o Unsteady Aerodynamics - Develop and verify reliable analytical methods to predict the unsteady aerodynamic forces under various operating conditions.
- o Noise Reduction - Improve understanding of the mechanisms by which propulsion components and flows generate noise, and develop the theories and validating data base for the reduction and accurate prediction of noise.

TARGETS:

- o Obtain detailed measurements in transition and separation region utilizing large low-speed tunnel - FY 1983.
- o Initiate shock noise studies with heated coannular jets - FY 1983.
- o Develop unsteady aerodynamic analyses and codes for prediction of propeller blade flutter and forced vibration - FY 1984.
- o Complete activation of large low-speed centrifugal compressor facility - FY 1985.
- o Validate far-field radiation model including geometry, flow and radiation interference effects - FY 1985.
- o Complete improved model of isolated high-speed turboprop near-field noise which is valid for transonic flow - FY 1985.

- o Complete and validate fundamental fan noise generation model which describes acoustic mode content and far-field noise - FY 1986.

- o Develop and verify models for generation and transport of nonaxisymmetric flows in high-speed core compressors - FY 1987.

- o Develop and verify aerodynamic damping and forcing function models - FY 1987.

JUSTIFICATION:

The emergence in recent years of advanced data processing machines has made it possible to start applying computational techniques for the complete solution of the flow equations, taking into account all variables such as viscous effects, time unsteady effects, and three-dimensional secondary flows. This will result in an impressive reduction in cost and time to improve and develop advanced turbomachinery components. Fundamental benchmark data is required for generation of flow models and verification of these new codes.

Unsteady aerodynamic codes will be coupled to advanced, structural dynamics codes to form a highly reliable aeroelastic prediction system. This will be used to extend the technology base for future aeropropulsion systems and ensure the aeroelastic integrity of bladed disc systems during the design phase, thus providing for very significant development and life-cycle cost reductions.

These unsteady flows and turbulence are also major sources of noise, which has an adverse effect on airport communities, vehicle passengers and crew. This program will provide the technology for prediction and reduction of aircraft noise.

SPECIFIC OBJECTIVE

TITLE: Combustion and Heat Transfer

Program/Discipline Objective Title: Fluid and Thermal Physics R&T

Responsible Organization/Individual: Aerospace Research Division/Stephen Wander

SPECIFIC OBJECTIVE:

To establish a more complete and basic understanding of fundamental combustion and heat transfer phenomena typical of gas turbine engines and to support the development of advanced computational techniques for accurately characterizing the governing aerothermodynamic processes.

- Fuels Research - Provide basic analysis and characterization of aviation fuels and establish a data base relating fuel chemical and physical properties (hydrogen-carbon ratio, viscosity, etc.) to combustion stability, ignition emissions and flame radiation.

- Combustion Fundamentals - Achieve a basic understanding of the fundamental aerodynamic and chemical processes which govern combustion and develop improved computer codes to analytically characterize the governing physical phenomena.

- Fundamental Fluid Mechanics and Heat Transfer - Provide increased knowledge and understanding of basic flow and heat transfer mechanisms and establish data base needed to develop more accurate modeling of boundary-layer behavior including film-cooling interaction, unsteady, secondary, separated flow and curvature effects in internal and rotating flow fields.

TARGETS:

- Complete review and identification of turbulence and turbulence-chemistry model deficiencies - FY 1983.

- Complete analysis and characterization of fuels synthesized from heavy petroleum and shale oil crudes - FY 1983.

- Establish nature of, and provide analytical models for describing, boundary-layer behavior and associated heat transfer on concave and convex curved surfaces with and without film cooling - FY 1984.

- o Measure temperature and species concentrations in high-speed mixing/reacting flows by nonintrusive optical means - FY 1984.

- o Complete turbulent flow benchmark experiments to verify analytical models of turbulent mixing phenomena within combustion processes - FY 1985.

- o Understand mechanisms and provide analytical models for leading-edge heat transfer in unsteady flow fields - FY 1986.

- o Identify critical parameters controlling boundary-layer transition in the turbine environment and provide analytical models for use in boundary-layer heat transfer calculations - FY 1986.

- o Define detailed reaction mechanisms and rate constants which describe fuel degradation (pyrolysis) processes - FY 1986.

- o Complete development of analytical models for fuel injection/vaporization and related combustion and soot formation effects - FY 1987.

JUSTIFICATION:

The rising costs of fabrication, testing and design modification make it increasingly important to reduce the trial-and-error methods associated with hot gas-path component development. Analytical modeling is an attractive alternative in that computational costs have decreased with increasing computer speed; conversational interactive time-sharing computer capability is extant; and computer graphics has been and is continuing to improve in speed and quality of performance. Advanced code development incorporating improved graphics, numerics and physical realism is predicated upon a more thorough and basic understanding of the fundamental aero-thermodynamics which governs the combustion and heat transfer processes in gas turbine engines. Obviously the accuracy and predictive capabilities of these advanced codes must be established by comparison with experimental data. Consequently, high-quality, fundamental benchmark experiments utilizing the most advanced instrumentation and diagnostic techniques represent a most essential and critical element of the program.

SPECIFIC OBJECTIVE

TITLE: Test Techniques

Program/Discipline Objective Title: Fluid & Thermal Physics R&T

Responsible Organization/Individual: Aerospace Research Division/Lana M. Couch

SPECIFIC OBJECTIVE:

To provide the technology and facilities for increased experimental research capability required to improve the measurement and prediction of aerodynamic and propulsion performance of current and advanced aircraft and missile designs.

- o Provide techniques for minimizing or eliminating testing errors due to wind-tunnel wall and support interference for both static and dynamic testing.
- o Advance instrumentation and measurement techniques for real-time flow diagnosis with emphasis on non-intrusive methods.
- o Extend development of transonic cryogenic wind-tunnel technology, test techniques, instrumentation, and model support and model design methods to ensure effective utilization of the National Transonic Facility (NTF).
- o Improve wind-tunnel technology, test techniques, and instrumentation for fundamental aerothermodynamic research.
- o Advance sensor and measurement systems required to characterize the basic thermal, flow, and elastic phenomena and the interactions and environmental phenomena of engines and components.

TARGETS:

- o Develop conceptual design and supporting documentation for an adaptive-wall test section for a large transonic wind tunnel - FY 1983.
- o Complete NTF tests on standard calibration models, including the 10^{o} transition cone, pathfinder-1 model, bodies of revolution, and the Shuttle orbiter model - FY 1983.

- Complete assessment of existing facility capability and flow quality for fundamental aerothermodynamic research into flow phenomena of large- to full-scale aircraft and missile surface geometries - FY 1983.

- Complete flight test of miniature multichannel pressure sensor system and an integrated sensor system - FY 1983.

- Develop final conceptual design for nonintrusive real-time data technique to detect transition locations on models tested in high Reynolds number, transonic cryogenic flow - FY 1983.

- Demonstrate performance of miniature heat flux sensors in a high-temperature, high-pressure combustor test rig - FY 1983.

- Establish final design criteria for a laser anemometer system for application to hot section component test rigs - FY 1983.

- Develop and demonstrate: (1) an LDV system that simultaneously measures 3 velocity components for application to large transonic wind tunnels, and (2) a holographic interferometry capability for the 11-foot transonic wind tunnel - FY 1984.

- Complete laboratory tests of high-accuracy fuel mass flow meter - FY 1984.

- Develop conceptual design and supporting documentation for a three-dimensional, self-streamlining wall test section and a fully compatible, large superconducting magnetic suspension system for the 7x10-foot high-speed tunnel - FY 1984.

- Complete high Reynolds number research tests of the pathfinder-11 model, pathfinder-1 controls wing model, and the LANN wing in the NTF - FY 1984.

- Develop and demonstrate miniaturized conventional sensors, thin film sensors, and laser speckle interferometry techniques for measuring temperature, heat flux, and dynamic and static strain on hot section components of turbine engines - FY 1984.

- Develop laser-based techniques for measuring fundamental gas flow properties and visualizing flowfield phenomena in a variety of engine applications, including turbine engine hot section components - FY 1984.

- o Develop combustion diagnostic instrumentation for real-time measurements of specie temperature and concentration, particle size distribution, and smoke number - FY 1987.

JUSTIFICATION:

NASA's strong position in advanced aerodynamic technology stems primarily from the development and application of advanced experimental facilities and techniques, closely coupled with advanced aerodynamic theories. New technology has resulted in the need for improved experimental facilities in both the transonic and high speed ranges, ground and flight test techniques, and instrumentation. Adequate simulation of critical shock/boundary flow interactions affecting vehicle performance prediction and minimizing testing uncertainties from tunnel-wall and model-support effects are critical for the high subsonic and transonic flow regimes. Recent developments in the areas of instrumentation, advanced tunnel-wall concepts and correction techniques, and the magnetic support and balance concept, plus the impending completion of the National Transonic Facility, provide advanced testing capability and measurement techniques needed for precise aerodynamic testing. Improvements in efficiency of gas turbine engines require more severe operating environments in the engine, plus reductions in component size and weight. Development of advanced high-durability, high-temperature, precision instrumentation is needed to provide analytical tools. Increased confidence in predictive capability will permit reduction of design margin uncertainties and will result in increased durability, reliability, and fuel flexibility of advanced engines.

SPECIFIC OBJECTIVE

TITLE: Applied Mathematics

Program/Discipline Objective Title: Fluid and Thermal Physics R&T

Responsible Organization/Individual: Aerospace Research Division/Randolph Graves

SPECIFIC OBJECTIVE:

To provide new mathematical methods and models and apply these to understanding aerospace phenomena, improving computer simulation and supporting advanced developments.

- o Extend utility of mathematical and numerical analysis.
- o Apply advanced computational techniques to the areas of fluid dynamics, acoustics, structural analysis, and controls and guidance.
- o Advance the state of the art in applied computer science.

TARGETS:

- o Improve spectral methods for the solution of Navier-Stokes 3-D flow by the end of FY 1983.
- o Develop mathematical models of acoustic propagation in the presence of turbulence by the end of FY 1983.
- o Apply conjugate gradient type methods to structural analysis and fluid dynamics in FY 1983.
- o Develop and verify a new algorithm for obtaining eigenvalues of large sparse matrices in FY 1983.
- o Develop improved iterative techniques for solving the steady state Euler equations by the end of FY 1984.
- o Develop improved parameter identification and control methods for large space structures by the end of FY 1984.

- o Develop advanced adaptive computing techniques for variable grids by FY 1984.

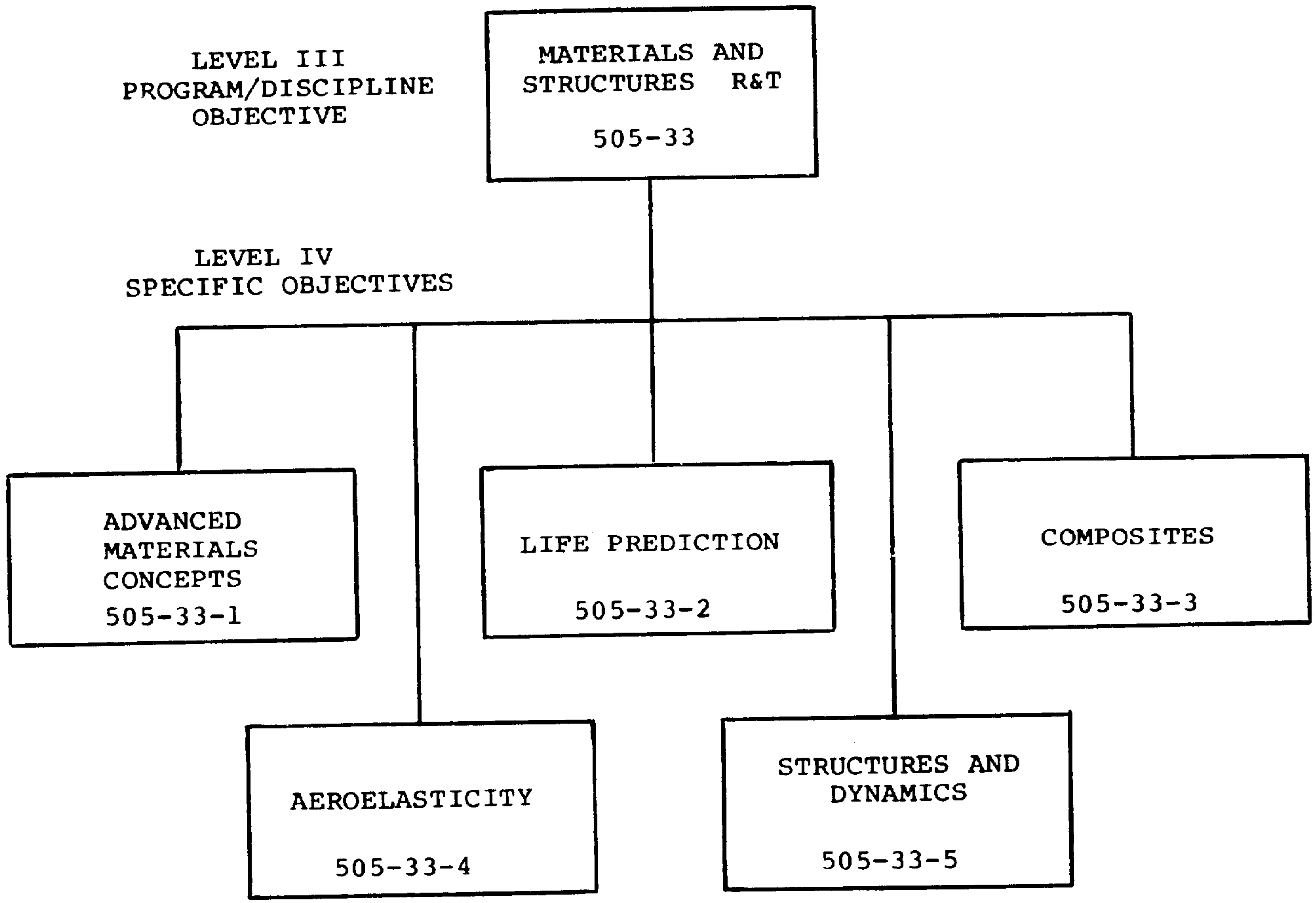
JUSTIFICATION:

Advances in applied mathematics and computer science are essential elements in the development of aerospace science and engineering. They are the tools engineers use in design, simulation, prediction, and analysis. Much research in applied mathematics and computer science is carried forward in meeting the objectives of practically all disciplines found in the programs of the Office of Aeronautics and Space Technology. The broad applicability of this field is shown in the recent progress made in solutions of partial differential equations, in development of new algorithms, and in evolution of new, efficient means for application of computers.

MATERIALS AND STRUCTURES R&T

MATERIALS AND STRUCTURES R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Materials and Structures R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aerospace Research Division/Charles F. Bersch

PROGRAM/DISCIPLINE OBJECTIVE:

To provide a materials and structures technology that will permit the aerospace industry to develop new and improved, safe and reliable metals, polymers, and ceramics and the application of these materials to advanced structures that will result in significant improvements in the performance, safety, durability, and economy of commercial, military and general aviation aircraft.

SPECIFIC OBJECTIVES:

- Advanced Materials Concepts: To provide materials and processing technologies for advanced metallic and ceramic materials that can contribute to improving the performance, life, reliability, structural efficiency, and/or to reducing the cost of future turbine engines and airframes for both commercial and military application.

- Life Prediction: To characterize and understand the fatigue and fracture behavior of metallic, ceramic, and composite materials in order to develop reliable life prediction techniques applicable to both engine and airframe structures.

- Composites: To exploit the full weight reduction potential of highly loaded composite airframe and engine structure via optimized characteristics of fibers and matrices, advanced damage-tolerant concepts, improved analytical prediction of composite properties, and understanding of environmental effects; and to achieve lower cost and greater reliability through the development of advanced processing techniques.

- Aeroelasticity: To develop improved methods for the analytical determination of loads, structural response, and stability of aerospace vehicles and develop more accurate unsteady aerodynamic theories, emphasizing the transonic range. To develop methods for prediction of forced dynamic response of rotating engine components and techniques to reduce structural response levels. To acquire reliable experimental data from wind-tunnel, rotor spin rig and flight test programs for use in validation of analytical methods. Demonstrate the effectiveness of advanced concepts, such as flutter suppression and load alleviation, using active controls and/or aeroelastic tailoring.

- Structures and Dynamics: To develop efficient integrated multidisciplinary analysis methodology and advanced structural and aerothermal computational methods needed to support the analysis and synthesis of airframe and engine components and systems; to define the means to reduce interior aircraft noise through structural modifications; and to investigate aircraft crash dynamics, including full-scale transport aircraft crash testing, and develop advanced methods for crash load prediction and load alleviation, providing improved transport crashworthiness.

SPECIFIC OBJECTIVE

TITLE: Advanced Materials Concepts

Program/Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Aerospace Research Division/Michael A. Greenfield

SPECIFIC OBJECTIVE:

To provide materials and processing technologies for advanced metallic and ceramic materials that can contribute to improving the performance, life, reliability, structural efficiency, and/or to reducing the cost of future turbine engines and airframes for both commercial and military application.

- o Improve the basic understanding of microstructure and materials behavior under airframe and engine operating conditions in order to develop improved physical and mechanical properties of advanced alloys, ceramics, and coatings.
- o Explore advanced concepts in metallic and ceramic materials and the related processing requirements that offer potential for higher material use temperatures and/or stresses in turbine engines.
- o Develop innovative joining and processing methods for incorporating advanced materials into efficient, low-cost airframe structures.

TARGETS:

- o Characterize the role of columbium in a nickel-based superalloy in FY 1983.
- o Achieve 60 ksi strength at 2500°F for non-hot pressed SIC/SI_3N_4 in FY 1984.
- o Characterize the strengthening mechanisms of cobalt and tantalum in superalloys so as to develop suitable substitutes by FY 1985.
- o Establish texture/thermomechanical processing relationship for high-temperature aluminum alloys by FY 1985.
- o Demonstrate a metallic coating with 10,000 hours rig life at 2000°F in FY 1986.

JUSTIFICATION:

Cost-benefit studies have established that major improvements in aircraft performance and economy can be obtained by increasing turbine engine operating temperatures and by reducing engine weights. The importance of such improvements has been re-emphasized by the national need to conserve fuel, reduce aircraft noise, and reduce engine pollution. Improved high-temperature materials would make possible higher specific thrusts, lower specific fuel consumption, greater reliability, and/or lower operating costs. Both civil and military aircraft would benefit from the use of improved materials. Improved materials are of such importance to the military that a coordinated, interdependent program has been developed with the Air Force on materials for aircraft turbines.

Advancements in airframe component fabrication and concepts directed at lighter weight, higher temperature, more corrosion-resistant alloys have a direct bearing upon direct cost of ownership and the viability of aircraft, both in terms of fuel efficiency and military performance.

SPECIFIC OBJECTIVE

TITLE: Life Prediction

Program/Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Aerospace Research Division/Michael A. Greenfield

SPECIFIC OBJECTIVE:

To characterize and understand the fatigue and fracture behavior of metallic, ceramic, and composite materials in order to develop reliable life prediction techniques applicable to both engine and airframe structures.

- To understand the interrelationship of a material structure and properties and to characterize microscopic deformation and cracking mechanisms as a basis to predict materials behavior and life.
- To develop nonlinear constitutive relationships and experimental techniques to characterize thermal and structural response of materials under realistic operating environments.
- To advance the state of the art in nondestructive evaluation so as to be able to better characterize defects and their location in complex structures and to determine material properties directly.

TARGETS:

- Extend crack closure models of propagation to include cracked holes in FY 1983.
- Demonstrate an NDE method to locate and evaluate composite delamination in real structures by end of FY 1984.
- Identify and characterize microscopic deformation and cracking mechanisms causing creep/fatigue by FY 1985.
- Develop generalized approach for defining the high-temperature constitutive material behavior for nonlinear structural analysis by FY 1985.

- o Demonstrate ability to measure residual stress by NDE in laboratory structures by FY 1986.
- o Demonstrate the ability to predict cyclic stress/strain response from uniaxial data for a combustor liner under multiaxial load by FY 1986.

JUSTIFICATION:

Maintenance and repair costs are a substantial part of the total direct cost to airlines. At the present time, this cost is nearly 11 percent of direct operating cost. Nearly 75 percent of military engine maintenance costs is due to the failure of hot section components, and 25 percent of all engine failures is attributed to fatigue. The fatigue and fracture program is aimed at improving procedures to predict fatigue crack initiation, crack propagation, and fracture of airframe and propulsion system materials and components. The improved life prediction procedures resulting from an increase in the knowledge of how materials behave under complex loadings and temperatures will contribute to increased service life and thus reduce operating costs.

SPECIFIC OBJECTIVE

TITLE: Composites

Program Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Aerospace Research Division/Charles F. Bersch

SPECIFIC OBJECTIVE:

To exploit the full weight reduction potential of highly loaded composite airframe and engine structure via optimized characteristics of fibers and matrices, advanced damage-tolerant concepts, improved analytical prediction of composite properties, and understanding of environmental effects; and to achieve lower cost and greater reliability through the development of advanced processing techniques.

- Synthesize, characterize and evaluate new and improved composite matrices and fibers for application in both airframe and engine structures.

- Develop the mechanics technology required for the design of efficient, fault-tolerant advanced structural components subject to combined loads, impact, post-buckling effects and local discontinuities.

- Determine the effects of expected service environments on the mechanical properties and lifetime of structural composites and joints.

- Develop adhesives and other joining or repair methods for more efficient utilization of composites, improved fire-resistant, nontoxic polymers and composites, and processing technology capable of providing very large (50 to 100 feet), thick, and variable thickness components.

TARGETS:

- Develop adhesives for joining aerospace structures with useful life of 10,000 hours at 450°F and 2000 hours at 550°F in FY 1983.
- Demonstrate an organic matrix resin with improved toughness and processibility compared to state of the art 350°F cure epoxies, while maintaining current mechanical properties, in FY 1984.
- Demonstrate the capability to predict real-time properties on the basis of accelerated tests by FY 1985.
- Demonstrate the ability to explain, improve, and measure toughness in composites by FY 1986.
- Demonstrate the ability to predict the post-buckling response of complex composite structures by FY 1986.
- Develop a processible 700°F resin for use in engine components by FY 1986.

JUSTIFICATION:

Improved materials contribute in a variety of ways to the ever-present demand for safer, more efficient and higher performing aircraft.

Composites have a vast potential for use in aircraft and engine structures because of a combination of lightweight, high strength, high stiffness, and a large degree of flexibility in tailoring properties to specific requirements. The lighter weight is directly transferable into such benefits as improved fuel economy.

Safe, efficient operation also requires reliability. To achieve this, a varied program covering environmental effects, flaw detection and prevention and improved fabrication and joining techniques must be conducted.

SPECIFIC OBJECTIVE

TITLE: Aeroelasticity

Program/Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Aerospace Research Division/Sam Venneri

SPECIFIC OBJECTIVE:

To develop improved methods for the analytical determination of loads, structural response, and stability of aerospace vehicles and develop more accurate unsteady aerodynamic theories, emphasizing the transonic range. To develop methods for prediction of forced dynamic response of rotating engine components and techniques to reduce structural response levels. To acquire reliable experimental data from wind-tunnel, rotor spin rig and flight test programs for use in validation of analytical methods. To demonstrate the effectiveness of advanced concepts, such as flutter suppression and load alleviation, using active controls and/or aeroelastic tailoring.

TARGETS:

- Complete a flutter compendium document for all analytical methods, experimental data and correlation studies conducted on turbine engines in FY 1983.
- Develop new concepts to increase engine rotor blade mechanical damping by FY 1984.
- Demonstrate, through flight tests in FY 1984, the effectiveness and practicality of the decoupler pylon concept for suppression of wing-store flutter.
- Develop the capability of using an integrated structures/controls/aerodynamic analysis technique to optimally apply active and passive controls technology in the design of efficient transport and military aircraft; validate by conducting flight experiments with unmanned drone aircraft (ARW-2 and ARW-3) by FY 1985.

- o Develop and validate efficient CFD nonlinear 3-D aeroelastic analysis methods by FY 1986.
- o Develop and validate analytical methods that account for dynamic coupling between turbine engine blades, disks and shafts, including friction interfaces by FY 1986.

JUSTIFICATION:

This objective aims at contributing to the technology base required to support future aircraft design goals, namely, improved performance, ride quality and service life, and lower costs. It seeks to provide improvements in the analytical and experimental techniques for predicting and controlling the unsteady aerodynamic loading, the structural dynamic response to this loading, and aeroelastic phenomena arising from the coupling of the two. The accurate prediction and effective control of these factors can result in lightweight, low-cost structural configurations.

There is a recognized need for improved prediction methods in unsteady transonic aerodynamics. Structural response computational methods need to be improved in order to more effectively account for the complex interactions with aerodynamics, flight controls, and propulsion forces. Wind-tunnel and flight test data are required to validate analytical advances and to demonstrate techniques for improving vehicle performance, ride quality and service life.

SPECIFIC OBJECTIVE

TITLE: Structures and Dynamics

Program Discipline Objective Title: Materials and Structures R&T

Responsible Organization/Individual: Aerospace Research Division/Sam Venneri and Deene Weidman

SPECIFIC OBJECTIVE:

To develop efficient integrated multidisciplinary analysis methodology and advanced structural and aerothermal computational methods needed to support the analysis and synthesis of airframe and engine components and systems; to define the means to reduce interior aircraft noise through structural modifications, and to investigate aircraft crash testing and develop advanced methods for crash load prediction and load alleviation, providing improved transport crashworthiness.

- o Develop and evaluate, by experiments, engine and airframe structural concepts and design methods for high-speed aircraft that achieve improved structural efficiency and durability.
- o Develop analysis and test methods to evaluate new concepts for improving transport aircraft crashworthiness and occupant survivability.
- o Develop methods for predicting structural response to noise and evaluate techniques for minimizing noise transmission.
- o Develop and validate optimization methods that include concurrent design constraints imposed by major engineering disciplines.
- o Develop and validate advanced analysis methods and design concepts for turbine engine structures.
- o Develop analytical methods for predicting the thermomechanical flight environments of airframe and engine components.

TARGETS:

- o Develop a methodology for global optimization of airframes and engine components under aerodynamic, structures and aeroelastic design constraints in FY 1984.

- Develop 3-D computational techniques for noise prediction by FY 1985.
- Develop definitive transport crash loads by full-scale testing and compare with analytical predictions by FY 1985.
- Develop advanced analysis and self-adaptive optimization methods to provide an interactive capability for analysis and synthesis of integrated engine components by FY 1985.
- Develop and validate structural concepts, joining techniques, and thermal management methods for M 4-7 aircraft by FY 1986.
- Develop a data base on composite structural behavior in transport aircraft under crash loading conditions by FY 1986.

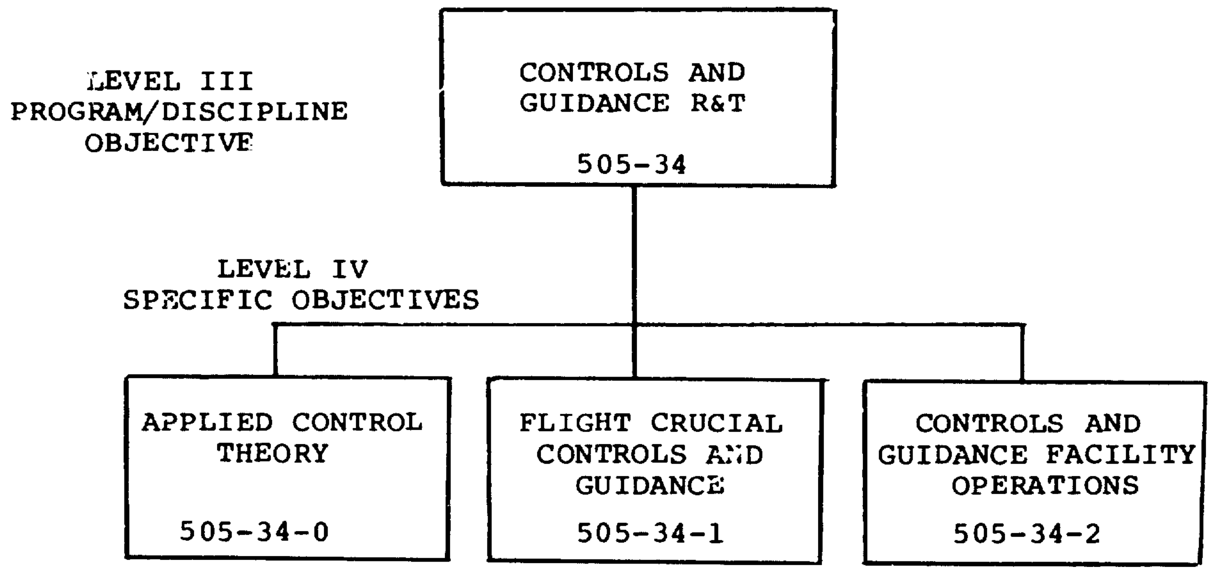
JUSTIFICATION:

Analysis and design methods have become an indispensable tool in the development of high-performance, environmentally acceptable and economical aeronautical systems. These requirements tend to intensify with time and necessitate corresponding advances in the analysis/synthesis methods on a continual basis. The development and utilization of new materials and design concepts require the development of efficient computational and optimization methods. Efficiency and performance improvements in high-speed cruise aircraft depend on development of structural design concepts which use innovative combinations of structural configurations, high-temperature materials, and thermal protection systems.

CONTROLS AND GUIDANCE R&T

CONTROLS AND GUIDANCE R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



505-34

PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Controls and Guidance R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual:
Aerospace Research Division/Herman A. Rediess

PROGRAM/DISCIPLINE OBJECTIVE:

Develop advanced controls and guidance theory concepts and design technology to improve performance, operating efficiency and mission effectiveness of civil and military aircraft in the late 1980's and 1990's.

SPECIFIC OBJECTIVES:

- o Applied Control Theory: To apply and extend advanced mathematical theories of estimation and control of aircraft dynamical systems and develop analysis, testing and synthesis techniques.

- o Flight-Crucial Controls and Guidance: To develop a technology base for the design, validation and assessment of flight-crucial controls and to develop advanced guidance concepts and crew station interface devices for improving aircraft flight path guidance.

- o Controls and Guidance Facility Operations: To provide the support services for operating controls and guidance research facilities.

SPECIFIC OBJECTIVE

TITLE: Applied Control Theory

Program/Discipline Objective Title: Controls and Guidance R&T

Responsible Organization/Individual:
Aerospace Research Division/Herman A. Rediess

SPECIFIC OBJECTIVE:

To apply and extend advanced mathematical theories of estimation and control of aircraft dynamical systems and develop analysis, testing and synthesis techniques.

- Advance the state of the art in control law concepts, control and estimation theory and analytical tools.
- Develop control system synthesis and modeling techniques for multidisciplinary application.
- Develop digital control theory techniques for propulsion systems control.
- Establish criteria and data base for highly augmented aircraft.

TARGETS:

- Complete development and evaluation of aircraft flight parameter estimation techniques for nonlinear regions of the flight envelope - FY 1983.
- Establish procedures for prediction of aeroelastic mode and control coupling influence on pilot ratings for advanced aircraft - FY 1983.
- Establish the theoretical framework for nonlinear inverse system control concepts - FY 1984.
- Demonstrate successfully that analytical redundancy techniques can accommodate control sensor failures - FY 1984.

JUSTIFICATION:

The underlying base for analysis, testing, and synthesis techniques necessary for advanced control systems is drawn for mathematical theories of estimation and control. The large body of control theory being developed in the academic community must be transformed into a language and format usable to the aeronautics engineers and evaluated for the aircraft controls applications. The transformation often, itself, leads to modifications and/or extensions of the basic theories. This specific objective provides the necessary ties between NASA and the academic and outside research community to draw the best national expertise to aircraft controls research.

SPECIFIC OBJECTIVE 505-34-1

TITLE: Flight Crucial Controls and Guidance

Program/Discipline Objective Title: Controls and Guidance R&T

Responsible Organization/Individual:
Aerospace Research Division/Herman A. Rediess

SPECIFIC OBJECTIVE:

To develop a technology base for the design, validation and assessment of flight-crucial controls and to develop advanced guidance concepts and crew station interface devices for improving aircraft flight path guidance.

- o Advance the state of the art in fault-tolerant technology including sensing and isolation redundancy management, diagnostic emulation, and assessment and validation methodologies.
- o Investigate lightning environmental effects.
- o Develop theory and techniques to design and evaluate advanced flight path guidance systems for future National Airspace System.
- o Develop advanced display concepts (joint with DOD) and information input/output techniques.

TARGETS:

- o Demonstrate techniques for performing normal and failure modes effects criticality analysis at the hardware and software design logic level through diagnostic emulation - FY 1983.
- o Improve brightness and color capability of TFEL materials and uniformity of varistar-addressed LCD materials - FY 1983.
- o Establish first experimental test plans for evaluating integrated system designs in AIRLAB - FY 1984.
- o Develop and simulate an advanced flight path management system for high-density, mixed-traffic airspace operations - FY 1984.
- o Evaluate the combination of physical redundant navigation sensors and analytical redundancy concepts to identify aircraft flight control anomalies - FY 1986.

JUSTIFICATION: 505-34-1

Because of performance and operational advantages, future aircraft must depend more heavily on automatic control systems that can provide some of the safety margins that have traditionally been provided by the basic airframe. This trend has already started with such vehicles as the Air Force F-16 fighter and the Lockheed L-1011 - 500. As the degree of dependence on control systems increases, the system reliability requirements increase which drives the technology toward a high degree of fault tolerance. Advances in fault-tolerance technology are needed on architectures, hardware and software, assessment techniques and verification, validation and testing methods.

The large number of aircraft currently operating in the U.S. has imposed such a burden on the National Airspace System as to cause excessive delays and wasted fuel. To improve operational efficiency, better techniques will be needed in flight path guidance, air traffic control, and the integration of the two. The advanced guidance laws, sensors, and crew interface research to support improved operational efficiency is conducted under this specific objective. The air traffic control integration aspects are covered under safety and human factors specific objectives.

SPECIFIC OBJECTIVE

505-34-2

TITLE: Controls and Guidance Facility Operations

Program/Discipline Objective Title: Controls and Guidance R&T

Responsible Organization/Individual:
Aerospace Research Division/Herman A. Rediess

SPECIFIC OBJECTIVE:

To provide the support services for operating controls and guidance research facilities.

- o Operate and maintain test equipment
- o Provide research equipment software support

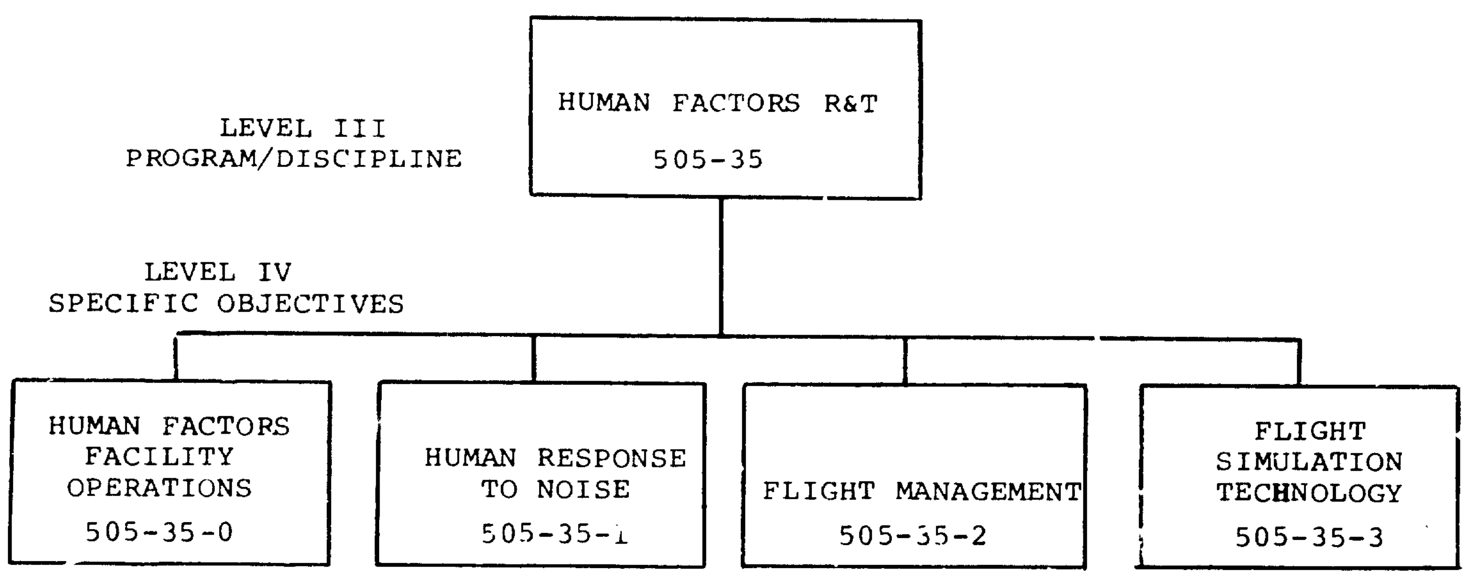
JUSTIFICATION:

Highly specialized ground-based research facilities are necessary for the experimental work which: a (1) demonstrates that advanced controls and guidance concepts are ready for the next stage of development and (2) assesses, in a realistic environment, the performance of highly integrated systems.

HUMAN FACTORS R&T

HUMAN FACTORS R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Human Factors R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aerospace Research Division/Herman A. Rediess

PROGRAM/DISCIPLINE OBJECTIVE:

To provide the research and technology base for solutions to the human problems impeding the growth or safety of air transportation.

SPECIFIC OBJECTIVES:

- Human Factors Facility Operations: To provide for the operations, maintenance and enhancement of the Man-Vehicle Systems Research Division's facility at Ames Research Center.
- Human Response to Noise: To develop technologies for quantifying and minimizing the impact of aircraft noise on airport community residents and on a ~~raft crews and passengers.
- Flight Management: To develop crew/cockpit/air traffic control (ATC) interaction technology base required to improve operational performance, capacity and safety.
- Flight Simulation Technology: To develop the technology base that will permit the economical and reliable substitution of simulators for actual flight operations in aeronautical research, development, and pilot training.

SPECIFIC OBJECTIVE

TITLE: Human Factors Facility Operations

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Aerospace Research Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To provide for the operation, maintenance and enhancement of the Man-Vehicle System Research Division's facilities at Ames Research Center.

JUSTIFICATION:

The Man-Vehicle Systems Research Division conducts a variety of human factors research programs for NASA, DOD, FAA, industry and other Government agencies in the areas of flight management systems, human factors in aviation safety, helicopter/ vertical takeoff and landing (VTOL) human factors, workload/performance measurement technology and simulation and training technology. The part-task and part-system experiment areas, computers and cockpit simulators in Buildings N-239 and N-239A and the Man-Vehicle Systems Research Facility (MVSRF) provide the capability for this research. A complete operations staff is required to provide the computer, scientific, and technical support for these facilities. Hardware- and software-related capital expenditures are required to upgrade and enhance these laboratories. Other facility service such as janitorial support, laboratory rehabilitation and modification and general building maintenance are also required.

SPECIFIC OBJECTIVE

TITLE: Human Response to Noise

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Aerospace Research Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To develop technologies for quantifying and minimizing the impact of aircraft noise on airport community residents and on aircraft crews and passengers.

TARGETS:

- o Develop technology for quantifying and minimizing airport community noise impact through aircraft operating procedures and land-use planning - FY 1983.
- o Develop vehicle specific noise and vibration criteria for use in the design of advanced turboprops and helicopters to meet community and cabin/cockpit acceptance - FY 1985.

JUSTIFICATION:

The air transportation system is under pressure to reduce the adverse effects of aircraft noise. These pressures cost the industry in terms of reduced aircraft operations, curfews, restrictions on airport development, litigation, and ill will within the airport community. The solution to the problem will require a concentrated effort by the manufacturers, airport operators and community planners. Unfortunately, no one of the above groups has the expertise and/or mission to develop the technology needed to formulate the problem in terms which can lead to technological solutions such as source noise reduction, flight procedures or land-use planning. Instead, the involved groups tend to rely on nontechnical methods such as restricted operations, noise limits, and public relations. NASA is in a unique position to attack the problem because of its expertise in the total air transportation system and its mission in aircraft noise reduction. Furthermore, NASA is viewed in this highly charged area as being an impartial producer of technology. The use of NASA expertise and facilities to develop the technology for quantifying

and ultimately minimizing the impact of aircraft noise on communities would greatly reduce the pressure on the industry to reduce noise through reduced operations.

In addition to the questions of community impact, there are a number of aircraft-specific questions involving the acceptability of unique or advanced designs such as helicopters and advanced turboprops. In the development and assessment of such vehicles, it is essential that both interior and exterior noise criteria are available for design, evaluation and/or certification efforts.

SPECIFIC OBJECTIVE

TITLE: Flight Management

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Aerospace Research Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To develop crew/cockpit/air traffic control (ATC) interaction technology base required to improve operational performance, capacity and safety.

TARGETS:

- o Evaluate the impact of probable air traffic control elements of the 1990's on crew performance, roles, and training, and develop solution concepts to these roles in terms of advanced flight deck environments - FY 1985.
- o Determine the feasibility of subdividing "workload" into component parts (e.g., mental, physical, emotional, etc.) and developing measures for each component - FY 1986.
- o Develop guidelines for aircrews to use in avoiding or minimizing the effects of fatigue and circadian desynchronosis - FY 1986.

JUSTIFICATION:

Air transport safety has improved consistently since World War II. These improvements are derived from a number of sources including improved pilot training, more reliable systems and structures, and advances in air traffic navigational and airport facilities. The aviation community, however, has been unable to reduce the incidence of accidents attributable to human error (about 60% for air transports and 80% for general aviation). The human error issue is thus one of the most serious facing the U.S. and world air transport industry. Larger aircraft and rapidly escalating liability judgments have made air transport safety crucial to the economic survival of the airline industry.

Recognizing the absolute necessity to mount a full-scale attack on the human error issue, the national and international aviation communities have joined forces to eliminate the human error problem. NASA is a full member of this team and is looked to solely to provide the scientific and technical insight necessary to solve the problem. The Aviation Safety Reporting System is NASA's primary tool in this endeavor.

The next generation of aircraft will make greatly increased usage of new types of displays made possible through the great strides that have been made in micro-electronics and flat-panel display technology. These include: cockpit display of traffic information (CDTI), head-up displays (HUD), collision avoidance systems (CAS), etc. Each of these will have to be thoroughly investigated to ensure that in solving existing problems, they do not introduce other problems.

Existing workload and performance measurement technology is not sufficiently advanced to permit the discriminations that need to be made. This is exemplified by the debates that have been encountered recently concerning the mandatory retirement of airline pilots at age 60, and the certification of new aircraft for any given crew complement.

Major questions about optimal crew roles and crew/system interfacing are being asked. Crew system communications including entry of information and system commands; the location, content, and format of displays; and procedures for accomplishing automated and manual functions must be specified. This program will provide the research base necessary to formulate these specifications and will result in implementation and flight testing of new hardware and software concepts in conjunction with human operators. It is anticipated that the resulting cockpit concepts will contribute substantially to future aircraft safety.

505-35-3

SPECIFIC OBJECTIVE

TITLE: Flight Simulation Technology

Program/Discipline Objective Title: Human Factors R&T

Responsible Organization/Individual: Aerospace Research Division/Melvin D. Montemerlo

SPECIFIC OBJECTIVE:

To develop the technology base that will permit the economical and reliable substitution of simulators for actual flight operations in aeronautical research, development, and pilot training.

TARGETS:

- o Develop guidelines for perceptually valid visual simulation of reduced visibility flight - FY 1983.
- o Develop improved methods for simulating flight under hazardous weather conditions - FY 1985.
- o Develop systematic methods and procedures for establishing simulation validity - FY 1986.

JUSTIFICATION:

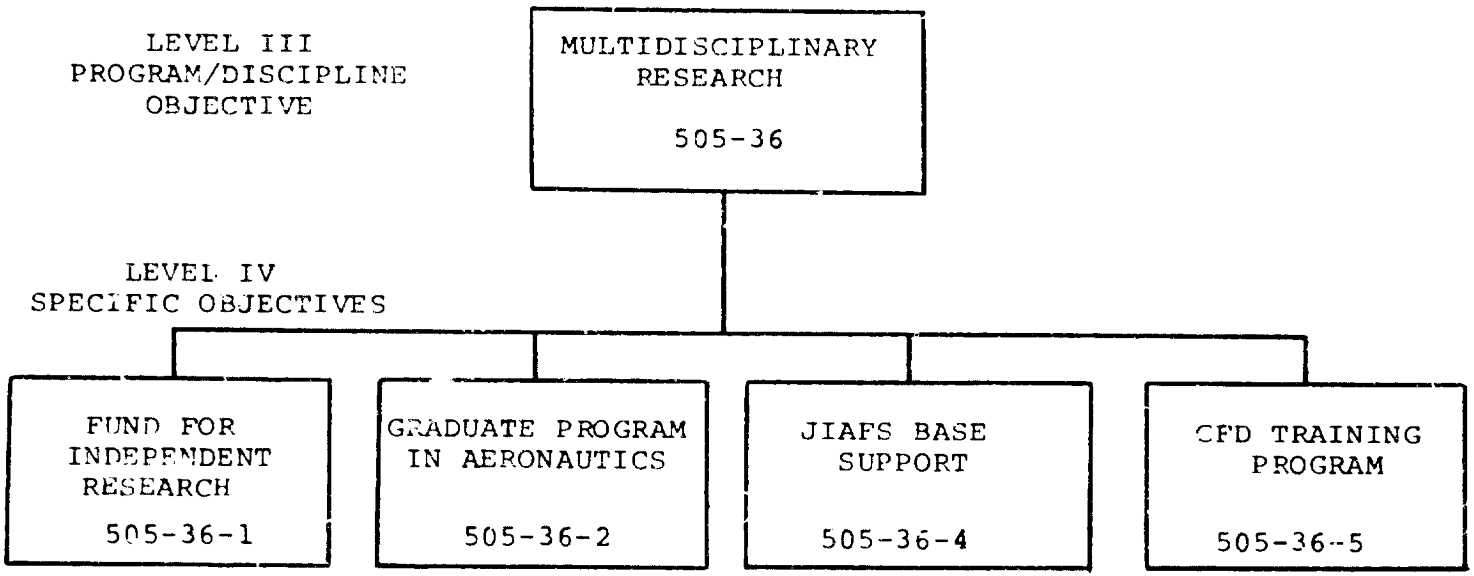
The ac antages of simulators over airborne flight training include reduced cost, fuel savings, safety and more efficient training. Investigations of the handling characteristics of new aircraft. practice of emergency procedures and maneuvers which can be hazardous if conducted in the air, and evaluation of new display and control systems, pilot capabilities, crew roles and flight procedures under possible future configurations of the air traffic system are but a few of the research and technology (R&T) areas where simulators play a vital role. In training, simulators permit repeated practice of a particular maneuver without the "set up" time necessary in airborne flight, provide the student with a permanent record of his performance, and permit stopping the "aircraft" for a review of critical points. The result is more effective and more efficient training, as recognized by the increasing allowance of simulator time as a substitute for actual flight time in pilot qualification and proficiency checks under Federal Aviation Administration (FAA) regulations.

Restrictions preventing wider usage of simulators were identified in a joint NASA/Department of Defense (DOD) study leading to the organization of the NASA/DOD Simulation Coordinating Group. This group meets semiannually to develop areas for agency interdependency. Items including F-15 simulator certification, motion transfer of training studies, and a data bank of simulation technology were addressed in 1977. The study also identified the inadequate understanding of perceptual cues associated with detection of acceleration and limitations in the technology for generating realistic visual scenes. In addition, the simulation fidelity required is known to vary with different R&T and training applications. However, clearly defined relationships have not been established. Because costs increase with the degree of fidelity realized, criteria relating fidelity and application are required. The research program described is responsive to the needs identified by the NASA/DOD study and the Simulation Coordinating Group. The anticipated consequence of this program is the cost-effective application of simulators on a broad scale.

MULTIDISCIPLINARY RESEARCH

MULTIDISCIPLINARY RESEARCH WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPI:NE OBJECTIVE

TITLE: Multidiscipli: .ry Research

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aerospace Research Division/Clinton E. Brown

PROGRAM/DISCIPLINE OBJECTIVE:

To conduct basic research of a multidisciplinary nature related to the field of aeronautics technology.

SPECIFIC OBJECTIVES:

- Fund for Independent Research: To conduct novel, long-range, high-risk, basic research investigations in engineering and physical sciences related to aeronautics through the support of unsolicited proposals and of proposals received in response to announcements of research opportunities in specific areas.

- Graduate Program in Aeronautics: To sponsor graduate training and research that is relevant and acceptable to both NASA and the university in the field of aeronautics. A significant portion of the training will be through stu... research conducted with faculty support at a NASA Center using NASA facilities.

- JIAFS Base Support: To provide a core level of funding for the Joint Institute for Advancement of Flight Sciences (JIAFS) which is an extension of the School of Engineering and Applied Science, George Washington University, located at Langley Research Center.

- CFD Training Program: To sponsor graduate training, for U.S. citizens only, in the interdisciplinary area of Computational Fluid Dynamics. To provide for the development of interdepartmental university curricula needed in CFD training.

505-36-1

SPECIFIC OBJECTIVE

TITLE: Fund for Independent Research

Program/Discipline Objective Title: Multidisciplinary Research

Responsible Organization/Individual: Aerospace Research Division/Randolph Graves

SPECIFIC OBJECTIVE:

To conduct novel, long-range, high-risk, basic research investigations in engineering and physical sciences related to aeronautics through the support of unsolicited proposals and of proposals received in response to announcements of research opportunities in specific areas, for example: turbulence modeling; drag reduction; controls theory; and propulsion efficiency.

JUSTIFICATION:

The Fund for Independent Research provides resources to support proposals for innovative research, investigate high-risk concepts, and initiate fundamental studies in areas not presently included in a specific discipline program of the Office of Aeronautics and Space Technology (OAST). It allows OAST to respond to new ideas and concepts in order to ensure the continued, long-term growth in aerospace technology.

SPECIFIC OBJECTIVE

TITLE: Graduate Program in Aeronautics

Program/Discipline Objective Title: Multidisciplinary Research

Responsible Organization/Individual: Aerospace Research Division/Randolph Graves

SPECIFIC OBJECTIVE:

To sponsor graduate training and research that is relevant and acceptable to both NASA and the university in the field of aeronautics. A significant portion of the training will be through student research conducted with faculty support at a NASA Center using NASA facilities.

JUSTIFICATION:

The training of skilled researchers for the field of aeronautics is a major concern of NASA, not only to staff its own Centers, but also to assure their availability for the entire aeronautical community. Started at the behest of Congress, the program of Graduate Training in Aeronautics provides for excellent interactions among students, faculty and NASA Center personnel to conduct good research.

505-36-4

SPECIFIC OBJECTIVE

TITLE: JIAFS Base Support

Program/Discipline Objective Title: Multidisciplinary Research

Responsible Organization/Individual: Aerospace Research Division/Randolph Graves

SPECIFIC OBJECTIVE:

To provide a core level of funding for the Joint Institute for Advancement of Flight Sciences (JIAFS), which is an extension of the School of Engineering and Applied Science, George Washington University, located at Langley Research Center.

JUSTIFICATION:

In the past JIAFS has received all of its support through several separate grants with the various research groups that it serves at Langley. However, this process places an unnecessary overhead burden on the negotiation of each grant for a small amount of administrative support and it fails to provide the flexibility to cover graduate stipends for top-flight graduate students until a grant can be negotiated. The JIAFS core funding will resolve the difficulties.

505-36-5

SPECIFIC OBJECTIVE

TITLE: CFD Training Program

Program/Discipline Objective Title: Multidisciplinary Research

Responsibile Organization/Individual: Aerospace Research Division/Randolph Graves

SPECIFIC OBJECTIVE:

To sponsor graduate training, for U.S. citizens only, in the interdisciplinary area of Computational Fluid Dynamics (CFD). To provide for the development of interdepartmental university curricula needed in CFD training.

JUSTIFICATION:

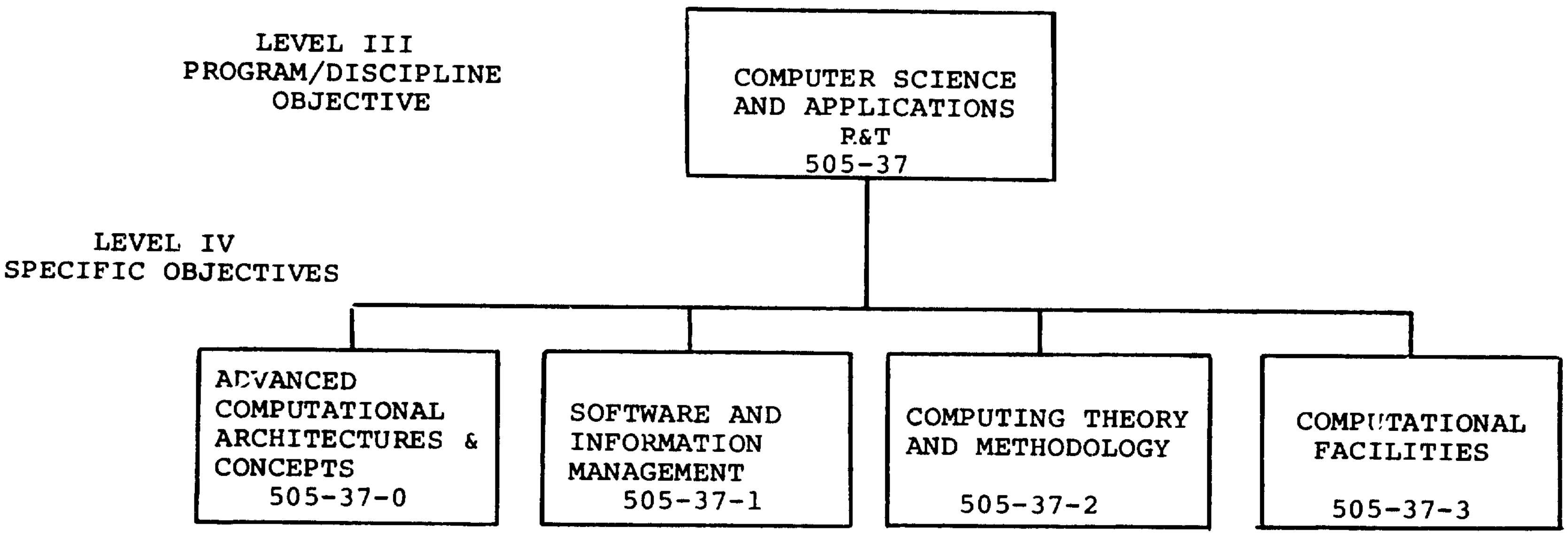
This training program is in response to the rapidly escalating need for specialists in CFD by NASA, DOD, and the national aerospace industry. This need grows out of the ever increasing use of computers to solve the complex equations of aerodynamics and propulsive flight. Because of the interdisciplinary nature of CFD, involving fluid physics, numerical methods, aerodynamics, and computer science, this program is required to focus the university curriculum on the specific CFD training needs. Students are offered summer employment at a NASA Center. This summer work program allows students to interact directly with specialists working in CFD.

9

COMPUTER SCIENCE AND APPLICATIONS R&T

COMPUTER SCIENCE AND APPLICATIONS R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Computer Science and Applications R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual:
Aerospace Research Division/Ronald L. Larsen

PROGRAM/DISCIPLINE OBJECTIVE:

To provide an agency foundation in fundamental computer science through research and experimentation, and to facilitate the infusion of state-of-the-art computer science and technology into aerospace applications. To provide the theoretical and technology base needed to develop advanced aerospace computing concepts and to evolve advanced system architectures in response to unique aerospace requirements. To improve the development process and the quality of aerospace-related systems and software. To provide advanced theory, concepts, techniques, and capabilities for the effective use and management of aerospace information. To provide state-of-the-art computational facilities for the conduct of research in computer science and technology for aerospace applications.

SPECIFIC OBJECTIVES:

- Advanced Computational Architectures and Concepts: To develop an understanding of the relationship and tradeoffs between algorithms and computer architectures for aerospace applications, and to apply this fundamental insight to the development of advanced computational concepts and optimal system architectures for this class of problems, with particular emphasis on computational modeling of physical processes and flight-crucial systems.

- Software and Information Management: To provide the theoretical and technology base for the development of aerospace-related software and information management systems. To provide the programming languages and techniques, software engineering methodologies and operating system concepts required for aerospace applications. To understand the fundamental models and principles underlying information management and provide the capability to manage scientific and engineering information.

- Computing Theory and Methodologies: To provide a technical foundation within NASA addressing theoretical and experimental computer science and computing methodologies which support the development of advanced aerospace-related systems. To investigate the theoretical basis underlying high reliability and fault tolerance of systems in order to provide insight into promising new architectural concepts. To provide the analyses required to understand the interplay between advanced architectural concepts and algorithm performance properties, including algorithmic complexity, time/space tradeoffs, convergence properties, and accuracy. To provide improved tools and techniques for analyzing and evaluating systems behavior and performance, including analytic techniques as well as simulation and modeling. To provide improved capabilities for communicating information between humans and computers, particularly through computer graphics.

- Computational Facilities: To provide state-of-the-art computational capability within NASA to support computer science and related aerospace research. This capability includes hardware and software, as well as the staff required for operations, maintenance, and planning. To provide the enhancements needed to ensure that the computational capabilities remain at the state of the art.

SPECIFIC OBJECTIVE

TITLE: Advanced Computational Architectures and Concepts

Program/Discipline Objective Title:
Computer Science and Applications R&T

Responsible Organization/Individual:
Aerospace Research Division/Ronald L. Larsen

SPECIFIC OBJECTIVE:

To develop an understanding of the relationship and tradeoffs between algorithms and computer architectures for aerospace applications, and to apply this fundamental insight to the development of advanced computational concepts and optimal system architectures for this class of problems, with particular emphasis on computational modeling of physical processes and flight-crucial systems.

TARGETS:

- o Publish state-of-the-art assessment of concurrent processing theory and technology, including but not limited to SIMD, MIMD, data flow, associative processors, and systolic array architectures, and considering the impact and role of VLSI and VHSIC technology - FY 1983.

- o Complete a comprehensive 10-year plan for NASA research and technology transfer on concurrent processing - FY 1983.

- o Establish a capability in conceptual, analytic and simulation modeling of concurrent processes and systems - FY 1983

- o Complete final design of the Numerical Aerodynamic Simulator - FY 1984

JUSTIFICATION:

Computational modeling of physical processes such as aerodynamic flow and structural dynamics has proven to be a highly effective methodology for conducting research, both in terms of cost and insight into fundamental phenomena of interest. Despite the incredible rate of technology advancement in the computing industry, this class of problems continues to levy computational demands which surpass state-of-the-art capability. NASA's requirements for highly reliable systems for flight

applications similarly go beyond contemporary technology.

The objectives of high performance and high reliability demand innovative architectural concepts in which multiple computational processes proceed concurrently, with varying levels of coupling between the processes, as the application demands. The uniqueness and pervasiveness of NASA's requirements for concurrent processing systems demand a strong technical base within the agency to conceive, design, analyze, and ultimately implement innovative system architectures for aerospace-related applications.

SPECIFIC OBJECTIVE

TITLE: Software and Information Management

Program/Discipline Objective Title:
Computer Science and Applications R&T

Responsible Organization/Individual:
Aerospace Research Division/Ronald L. Larsen

SPECIFIC OBJECTIVE:

To provide the theoretical and technology base for the development of aerospace-related software and information management systems. To provide the programming languages and techniques, software engineering methodologies and operating system concepts required for aerospace applications. To understand the fundamental models and principles underlying information management and provide the capability to manage scientific and engineering information.

TARGETS:

- Publish a state-of-the-art survey and assessment of highly reliable software theory and technology - FY 1983.
- Complete a comprehensive 10-year plan for NASA research and technology transfer on highly reliable software - FY 1983.
- Establish a capability for software research focusing on the development of highly reliable software - FY 1983.
- Develop a technical base for the representation of system design information supporting presentation from many different viewpoints - FY 1983.
- Assess reliability, performance, and user interface of the SIFT and FTMP systems for highly reliable computing - FY 1983.
- Establish IPAD data-base management software on CDC host computer, including geometry capability and limited computer networking - FY 1985.
- Develop a prototype Finite Element Machine (FEM) using microprocessors to demonstrate efficient computational methods for large-scale structural analysis applications - FY 1985.

JUSTIFICATION:

In many ways, NASA is an information-intensive organization. Much of its mission is to collect, organize, and reduce data into usable scientific information. Computing is essential to achieving its objectives, evidenced by the annual expenditure of nearly a quarter of its total budget for computing and computing-related services. Given the magnitude of its continuing investment, it is essential that the agency have the technical base to utilize this technology wisely and fully. Active research and vigorous technology infusion must be conducted to maximize NASA's return on its annual investments and to assure the development of computing systems which efficiently and effectively meet NASA's needs and the needs of the aerospace scientific and industrial community.

505-37-2

SPECIFIC OBJECTIVE

TITLE: Computing Theory and Methodology

Program/Discipline Objective Title:
Computer Science and Applications R&T

Responsible Organization/Individual:
Aerospace Research Division/Ronald L. Larsen

SPECIFIC OBJECTIVE:

To provide a technical foundation within NASA addressing theoretical and experimental computer science and computing methodologies which support the development of advanced aerospace-related systems. To investigate the theoretical basis underlying high reliability and fault tolerance of systems in order to provide insight into promising new architectural concepts. To provide the analyses required to understand the interplay between advanced architectural concepts and algorithm performance properties, including algorithmic complexity, time/space tradeoffs, convergence properties, and accuracy. To provide improved tools and techniques for analyzing and evaluating systems behavior and performance, including analytic techniques as well as simulation and modeling. To provide improved capabilities for communicating information between humans and computers, particularly through computer graphics.

TARGETS:

- o Begin full-scale operation of the Research Institute for Applications of Computer Science - FY 1983.
- o Establish a technical base capability for theoretical research in reliability and fault tolerance - FY 1983.
- o Establish a capability for conducting fundamental research in algorithm analysis, complexity measures, and formal logic - FY 1983
- o Develop computer graphic techniques for modeling and representation of three-dimensional objects - FY 1984.
- o Complete assessment of coupling multiple mainframe computers and array processors to large backing store memory - FY 1984.

JUSTIFICATION:

NASA's computational requirements push the state of the art in several directions which tend to be unique to aerospace applications, e.g., in aerodynamic design and avionics. Performance and reliability are two dimensions in which the agency's requirements severely stretch the capabilities of conventional approaches and system architectures, spawning projects such as NAS, SIFT, and FTMP. Development projects such as these are resource-intensive and time-consuming; conceptual and design errors can be extremely costly. While conceptual intuition, insight, and engineering rigor have historically served projects such as these well, continuing increases in problem and system complexity necessitate a strengthening of the agency's theoretical foundations in the design, analysis, and modeling of algorithms and computational systems.

Effective means of presenting immense volumes of spatial information to humans are only beginning to be developed, and the value of alternative representations is poorly understood. Much of NASA's fundamental and applied research involves the management and presentation of spatial information, from the display of aerodynamic flow fields to the portrayal of structural designs. While computer graphics is an active field of industrial and academic research, effective techniques for communicating 3-dimensional information remain a research issue of fundamental importance to NASA and the aerospace community.

SPECIFIC OBJECTIVE 505-37-3

TITLE: Computational Facilities

Program/Discipline Objective Title:
Computer Science and Applications R&T

Responsible Organization/Individual:
Aerospace Research Division/Ronald L. Larsen

SPECIFIC OBJECTIVE:

To provide state-of-the-art computational capability within NASA to support computer science and related aerospace research. This capability includes hardware and software, as well as the staff required for operations, maintenance, and planning. To provide the enhancements needed to ensure that the computational capabilities remain at the state of the art.

TARGETS:

- Provide High-Speed Analytical Processor (HSAP) hardware and software at LeRC for research on computational modeling of physical processes (e.g., aerodynamic analysis and thermal and structural performance analysis of propulsion system components - FY 1983.

- Upgrade memory and improve communications on the ARC Class VI computer - FY 1983.

- Provide computer science researchers at the NASA aeronautics Research Centers with access to state-of-the-art computational facilities - FY 1984.

- Provide sufficiently high-speed inter-Center computer communications network capability with the associated network gateways and software to facilitate the sharing of resources among computer science research organizations at the NASA Centers - FY 1984.

JUSTIFICATION:

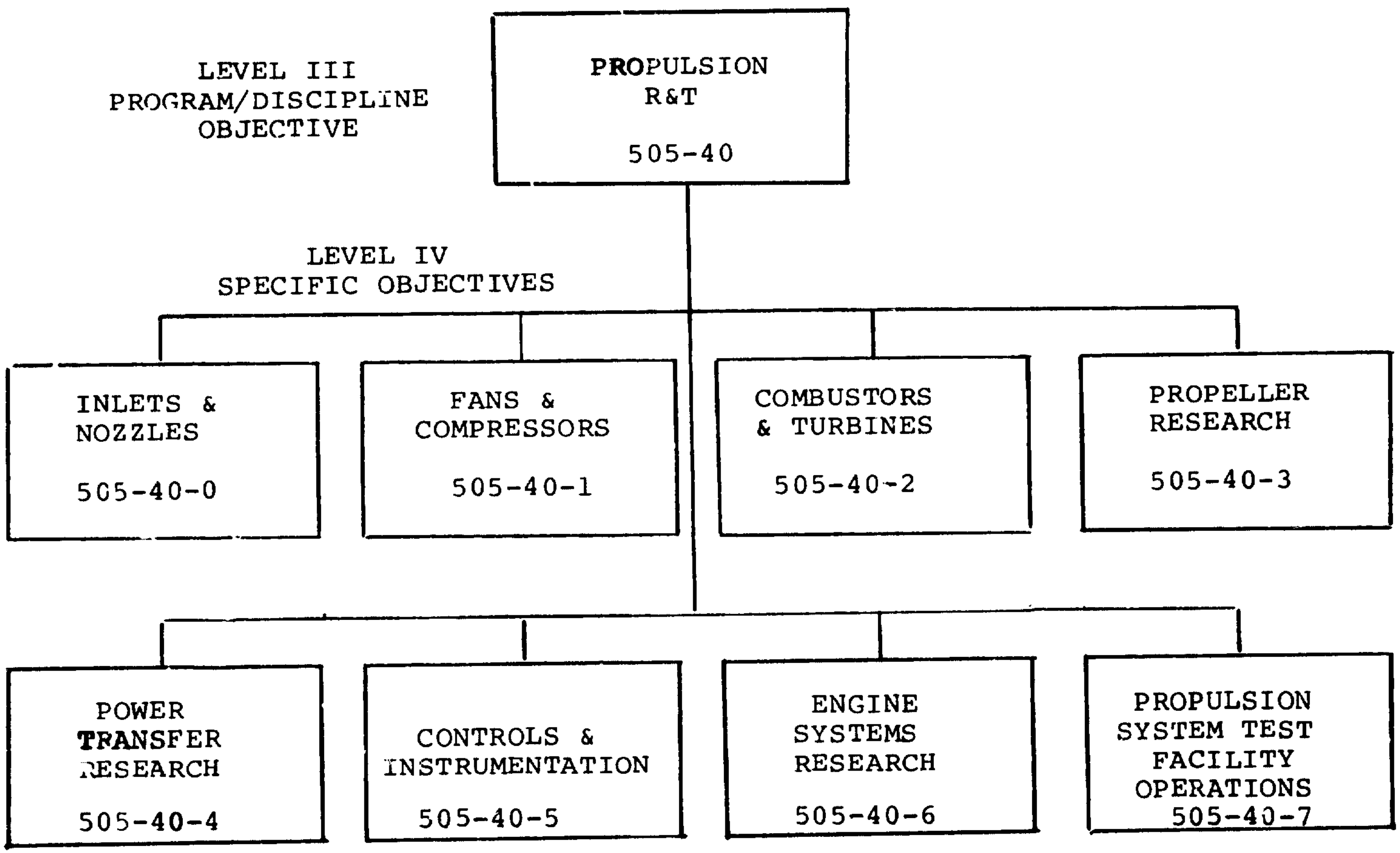
State-of-the-art computational facilities must be provided to attract and retain competent computer scientists and to support a wide range of computer science and aerospace research and development activities. The unique capabilities of the advanced computational facilities provide the large-scale computer resources needed to further the state of the art in computational analysis, further research into the basics of fluid motions, and to support systems and software.

10

PROPULSION R&T

PROPULSION R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Propulsion R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aeronautical Systems Division/Cecil C. Rosen

PROGRAM/DISCIPLINE OBJECTIVE:

To provide, through applied technology and experimental evaluation, the knowledge, understanding, and technology base necessary to achieve safer and more energy efficient, economical, reliable, and environmentally acceptable propulsion systems for future aircraft of all types ranging from small general aviation aircraft and helicopters to commercial transports and military aircraft.

SPECIFIC OBJECTIVES:

- Inlets and Nozzles: To develop the design methodology and extend the experimental data base for inlets, nozzles, and internal engine ducting to achieve higher performance with increased propulsion system stability.

- Fans and Compressors: To improve efficiency, operating range, distortion tolerance, durability, and reliability, and to reduce the weight, volume, and cost of fans and compressors required for advanced propulsion systems.

- Combustors and Turbines: To improve performance, reliability, durability, and fuel flexibility of advanced combustors and turbines for future civil and military applications.

- Propeller Research: To advance the technologies which are critical to efficient, acceptable propeller propulsion both at high subsonic speeds (Mach 0.7 to 0.8) and at lower speeds typical of general aviation and commuter aircraft.

- Power Transfer Research: To develop and verify generic computational techniques and to advance the technology of bearings, gears, transmissions, and lubrication systems to achieve improved life, reliability, efficiency, and performance in the high-temperature, high-pressure, and high-speed environment of advanced gas turbine engines and mechnical power transmission systems.

- Controls and Instrumentation: To provide an improved technology base for future engine control systems and related instrumentation and measurement systems development for safe, reliable operation of future engine systems.

- Engine Systems Research: To establish the technology base for advanced general aviation engines with reduced fuel consumption, weight, emissions, broad-specification fuels capability, lower cost and maintenance, and improved reliability; to improve the understanding of propulsion system dynamic behavior and develop engine dynamic prediction techniques; and to investigate the feasibility and potential benefits of new or unusual engine technologies and/or concepts for future military and commercial aircraft.

- Propulsion System Test Facility Operations: To provide safe and productive operations of the wind tunnel and engine test facilities for propulsion systems research at the Lewis Research Center.

SPECIFIC OBJECTIVE

TITLE: Inlets and Nozzles

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Aeronautical Systems Division/Paul G. Johnson

SPECIFIC OBJECTIVE:

To develop the design methodology and extend the experimental data base for inlets, nozzles, and internal engine ducting to achieve higher performance with increased propulsion system stability.

- o System Prediction - Develop comprehensive flow prediction methodology for the analysis and design of realistic inlet, duct, and nozzle configurations.

- o Code Validation - Verify and improve analytical codes by means of benchmark experiments which provide detailed definition of the phenomena in subsonic and supersonic duct flows.

TARGETS:

- o Verify Navier-Stokes code for steady 2D throat shock/boundary layer interaction by comparison with data of Sabjen - FY 1983.

- o Complete exhaust flow mixer analysis by including swirl and thrust calculations - FY 1984.

- o Extend the experimental data base to validate axisymmetric inlets at angle of attack - FY 1985.

- o Verify 3D subsonic viscous marching analysis for S-duct diffusers using incompressible LDV data and compressible probe data - FY 1985.

- o Verify code for internal flow of an axisymmetric inlet at zero angle of attack - FY 1986.

JUSTIFICATION:

Today's supersonic inlets are designed for short-duration operation at supersonic flight Mach numbers and are relatively inefficient at sustained supersonic cruise. Many three-dimensional inlet and nozzle geometries are not currently amenable to analysis. Advancing the state of the art requires integrating codes for the diverse flow regimes of nozzles and inlets (such as the boundary-layer control system, terminal shock and subsonic diffuser). Into a comprehensive prediction capability which can take into account geometric complexities and the interactions of the various flow regimes. Such an overall flow prediction capability is needed to analyze and design realistic inlet, duct and nozzle configurations. Advances in computational methods will lead to improvements in installed performance through optimized minimum drag integration of the propulsion system and airframe.

SPECIFIC OBJECTIVE

TITLE: Fans and Compressors

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Aeronautical Systems Division/John J. McCarthy

SPECIFIC OBJECTIVE:

To improve efficiency, operating range, distortion tolerance, durability, and reliability, and to reduce the weight, volume, and cost of fans and compressors required for advanced propulsion systems.

- o Compressor Stall Recovery - Develop a fundamental understanding of compressor stalling phenomena and how it is influenced by compressor design parameters. Also develop a model for predicting stalling characteristics/ recovery of advanced compressors.
- o High-Speed Verification Experiments - Conduct detailed flow-field measurements in single- and multi-stage compressors utilizing LDV or other advanced instrumentation techniques to verify analytical codes.
- o Component Research - Improve the performance, efficiency, and operating range of axial and centrifugal flow compressors by applying advanced analytical codes, exploring new concepts, and developing techniques and concepts to minimize adverse size-related flow and geometric effects.

TARGETS:

- o Assess the effect of stage design pressure coefficient on the stalling characteristics and recovery of advanced single stages representative of core compressor inlet stages - FY 1983.

- o Conduct detailed flow-field measurements within the blading of advanced single stages and core compressor inlet stage groups to provide verification of flow analysis codes - FY 1984.

- o Improve the capability to predict the unstalled performance characteristics by extending the design/off-design codes to include 3D and secondary flow effects - FY 1984.

- o Determine the effect of speed, aspect ratio, vane schedule, and casing treatment on the stalling characteristics and recovery of a high-speed, highly loaded core compressor inlet stage group - FY 1984.

- o Obtain fundamental data from large low-speed compressors on stall inception and recovery for modeling and code verification - FY 1985.

- o Develop and verify design methodology to minimize the adverse effects of scaling large compressors to a small size - FY 1986.

- o Determine the effects of stage reaction, pressure coefficient and flow coefficients on the stalling characteristics and recovery of an advanced core compressor inlet stage group - FY 1986.

- o Develop a generic model which will predict the stalling characteristics and recovery of a wide variety of single- and multi-stage fans and compressors - FY 1986.

- o Determine the stalling characteristics and recovery of advanced high-speed axial and core axial/centrifugal core compressors to validate compressor models - FY 1988.

JUSTIFICATION:

Fundamental disciplinary research on fans and compressors enhances basic understanding in critical areas that continue to have a strong influence on overall progress in aeronautical propulsion. This ongoing research provides technical advances to support efforts within NASA to improve and advance propulsion systems that permit aircraft to operate more efficiently over a wider range of flight speeds and altitudes.

Advanced military aircraft engines require lightweight fans and compressors which are efficient over a broad range of operating conditions. They must have adequate stall margin to permit stable operation with severely distorted inlet flows. Commercial applications such as energy efficient transport aircraft have similar requirements for advanced turbomachinery and in addition require low fuel consumption, and improved durability and maintainability. Advanced V/STOL, rotorcraft and general aviation propulsion systems also need efficient, lightweight, durable and reliable components. Continued R&D is required to improve cycle efficiency through increased pressure ratio and component efficiencies.

The component sizes being investigated span the range covering small civil helicopters at the low end and large jumbo-jet transports at the upper end of the size range. Both civil and mili[illegible] missions are included. Small compressor research is conducted jointly with the U.S. Army, and the compressor stall recovery research is a joint program with the U.S. Air Force.

SPECIFIC OBJECTIVE

TITLE: Combustors and Turbines

Program/Discipline Objective Title: Propulsion R&T

Responsible Organization/Individual:
Aeronautical Systems Division/John J. McCarthy

SPECIFIC OBJECTIVE:

To improve performance, reliability, durability, and fuel flexibility of advanced combustors and turbines for future civil and military applications.

- Combustor Modeling - Improve and validate analytical codes and models for predicting combustor internal aerothermodynamic performance and combustor exit conditions.

- Generic Combustor Research - Identify and evaluate subcomponent/component level technology for inlet air diffusion and modulation, fuel injection and fuel/air preparation, liner cooling, primary zone stoichiometry control and exit condition tailoring. Establish data base relating effects of fuel chemical and physical property variations on combustor performance, durability, and emissions.

- Turbine Aerodynamics Research - Perform detailed flow mapping in cascades and rotating blade rows to develop performance prediction and viscous flow analysis methods and techniques for improved aerodynamic, cooling and variable geometry components.

- Cooled Turbine Technology - Determine factors that influence accuracy of internal and external flow and heat transfer predictions and develop improved analytical methods to support advanced cooled turbine component technology.

TARGETS:

- Complete combustor tests to assess the effects of fuel property variations on combustor performance independent of injector-induced fuel spray characteristics - FY 1983.

- Evaluate advanced liner cooling concepts (transpiration and CFFC) for advanced combustor designs - FY 1983.

- o Identify the geometric and aerodynamic parameters penalizing the efficiency of small turbine stators vis-a-vis large turbines and quantify the performance effects - FY 1983.

- o Evaluate full-coverage film-cooled vanes and blades in the HPT at 300 psia and 3200°F to verify predicted metal temperatures - FY 1983.

- o Measure local heat fluxes on cooled vanes and blades in the HPT at current engine conditions - FY 1984.

- o Establish effect of upstream temperature profile on turbine performance and determine nature of temperature profile redistribution within a turbine stage with and without cooling - FY 1985.

- o Establish 2D, unsteady stochastic numerical method for combustor modeling - FY 1985.

- o Complete test demonstration of advanced combustor concepts (multi-zone, variable geometry) for burning zone stoichiometry control - FY 1986.

- o Verify design methods and criteria for radial-outflow combustors - FY 1987.

JUSTIFICATION:

The trend toward increased operating pressures and temperatures in aircraft gas turbine and engines places an increasing burden on combustor and turbine systems to perform reliably over extended periods of operation while potentially experiencing significant fuel property variations. Improved computer models, able to adequately characterize highly complex turbulent reacting flows, are essential to the design of future combustors optimized for maximum combustion efficiency, durability, and minimum environmental impact. Improvements in turbine design technology required for continued U.S. leadership in the aircraft engine industry will be achieved only through a complete understanding of boundary layer behavior in turbine passages and the concomitant ability to predict this behavior. Critical elements in the development of rigorous computer codes for hot gas-path flow-field modeling and component performance prediction include highly accurate non-intrusive instrumentation techniques, component rig tests, and verification experiments in near-engine environments.

SPECIFIC OBJECTIVE

TITLE: Propeller Research

Program/Discipline Objective Title: Propulsion R&T

Responsible Organization/Individual: Aeronautical Systems Division/Paul G. Johnson

SPECIFIC OBJECTIVE:

To advance the technologies which are critical to efficient, acceptable propeller propulsion both at high subsonic speeds (Mach 0.7 to 0.8) and at lower speeds typical of general aviation and commuter aircraft.

- Conduct analytical and experimental investigations of advanced propellers incorporating integrated aerodynamic, acoustic and aeroelastic design for flutter-free operation at both high subsonic flight conditions (up to Mach 0.8 and 35,000 feet altitude) and low speeds (Mach 0.6 and below).
- Document acoustic characteristics of both advanced high tip-speed propellers (propfans) and advanced low-speed propellers, and develop design techniques to reduce propeller source noise and reduce noise and vibration transmission into cabin interiors.
- Conduct analytical and experimental investigations of wing- and aft-mounted turboprop installations to minimize flow interactions involving propeller, slipstream, inlet, nacelle and airframe.

TARGETS:

High Subsonic Speed Propellers:

o Document noise attenuation characteristics of fuselage concepts, and complete initial structure-borne noise investigation.	FY 1983
o Complete wind tunnel investigation of contoured over-the-wing (OTW) nacelle on baseline semi-span wing.	FY 1983
o Assess lifting surface codes by comparison with LDV measurements.	FY 1983
o Obtain verification data to define propfan wake and radial loading.	FY 1984

o Complete wind-tunnel investigation of improved OTW nacelle installation on optimized semi-span wing.	FY 1984
o Complete subscale aeroelastically-scaled propfan model test program.	FY 1985
o Determine natural frequencies and vibratory modes of large-scale blade and complete fatigue test.	FY 1985
o Obtain aerodynamic performance and wake data for a counterrotating propeller.	FY 1986

Low-Speed Propellers:

o Demonstrate performance of several unique propeller geometries capable of at least 5 percent fuel savings.	FY 1984
o Validate preliminary integrated design/ analysis computer codes for commuter and general aviation propellers.	FY 1984
o Demonstrate efficiency of composite propeller blades 25 percent lighter in weight than current blades.	FY 1987

JUSTIFICATION:

An opportunity is available to greatly enhance the fuel efficiency of transport aircraft through the application of advanced high-speed turboprop propulsion. Estimates indicate the potential for a 15- to 20-percent savings in block fuel relative to advanced turbofans without sacrificing cruise speed (Mach 0.7 to 0.8), altitude (to 35,000 feet) or cabin environment. The propeller research program is structured to advance the major interrelated technologies which must ultimately be integrated into fuel-conservative, high-subsonic turboprop aircraft. The program will also provide the propeller data base needed for efficient, quiet, lower speed aircraft. Enhancement of these characteristics will increase the productivity and broaden the beneficial application of propeller aircraft, both civil (commuter, general aviation) and military (RPV, continuous patrol aircraft, intratheater transport).

SPECIFIC OBJECTIVE

TITLE Power Transfer Research

Program/Discipline Objective Title:
Propulsion R&T

Responsible Organization/Individual:
Aeronautical Systems Division/Paul G. Johnson

SPECIFIC OBJECTIVE:

To develop and verify generic computational techniques and to advance the technology of bearings, gears, transmissions, and lubrication systems to achieve improved life, reliability, efficiency, and performance in the high-temperature, high-pressure, and high-speed environment of advanced gas turbine engines and mechanical power transmission systems.

- Mechanical Components - Explore innovative concepts and design methodology for durable and efficient bearings and gears.
- Transmissions - Develop advanced concepts and verify efficient and reliable gear, traction, hybrid, and variable speed transmissions.

TARGETS:

- Complete dynamic analysis of high-contact-ratio internal and external spur gears including rim effects and multiple paths for planetary gearing - FY 1984.
- Complete validation of 500 H.P. and 3000 H.P. hybrid transmission concepts and identify and quantify the effects of scale - FY 1984.
- Complete validation of 500 H.P. split torque transmission concept - FY 1984.
- Complete validation of 500 H.P. Bearingless Planetary Transmission concept - FY 1984.

- o Verify predictive models for gear and bearing life which reflect the effects of design and operating variables typical of turboprop, rotorcraft, and gas turbine applications - FY 1985.

- o Demonstrate acceptable life and mechanical integrity of advanced case carburized high-temperature ball bearings operating at 3.0 million DN - FY 1985.

- o Extend the analytical and experimental technology base to large, high-speed gears typical of advanced turboprop applications - FY 1985.

JUSTIFICATION:

Power transfer research is focused on evolving the technology of mechanical components and transmissions for aircraft gas turbine engines, helicopter transmissions, interconnects on V/STOL aircraft, and speed reducers for high-efficiency turboprops and geared-fan engines. Advances in mechanical components such as bearings and gears are required, not only to improve performance, efficiency, life, and durability of engines and transmissions, but also to enable designers to take full advantage of advances in structures and aerodynamic components.

The realization of reduced operating cost, reduced weight, improved operating life and reliability for future generation helicopter drive systems can only be obtained through advanced research and development. These activities will provide a solid technology base for the development of advanced civil and military helicopter transmissions, as well as provide a generic base for advances in gear technology for high-speed turboprop systems of the future. These activities are conducted jointly with the U.S. Army.

SPECIFIC OBJECTIVE

TITLE: Controls and Instrumentation

Program/Discipline Objective Title: Propulsion R&T

Responsible Organization/Individual:
Aeronautical Systems Division/John R. Facey

SPECIFIC OBJECTIVE:

To provide an improved technology base for future engine control systems and related instrumentation and measurement systems development for safe, reliable operation of future engine systems.

- Controls - Develop real-time simulation capability to provide control mode optimization for engine operation and monitoring, as well as innovative sensors and actuators for increased capability and reliability.

- Instrumentation - Develop and apply new or improved measurement systems for use in component and engine systems research to define operating environment and engine component interactions for both ground-based and flight applications.

TARGETS:

- Validate design of 1700°C optical temperature sensor - FY 1984.

- Evaluate control modes for avoidance of, and recovery from, rotating stall using engine simulation - FY 1984.

- Demonstrate the operation of a general purpose parallel-microcomputer simulator having capability for all classes of propulsion systems - FY 1985.

- Develop the technology needed for producing pressure transducers that are capable of making precision measurements at temperature levels up to 800°K (1000°F) - FY 1985.

- Demonstrate long-life 250°C optically-switched actuator - FY 1986.

- Evaluate control modes for avoidance of and recovery from rotating stall using engine system evaluation - FY 1986.

- Develop the silicon carbide technology needed for producing electronic components, devices, and systems that are capable of operation in the temperature range of 500°K (450°F) to 800°K (1000°F) - FY 1986.

JUSTIFICATION:

As engine performance has been increased for both military and commercial aircraft, engines have become increasingly complex with higher and higher internal pressures and temperatures. The increased complexity includes propulsion system primary component variability throughout an aircraft's flight regime. Thus, engine control systems are required to monitor and control an increased number of variables which require advanced control hardware and new modes of control operation to maintain optimized, as well as safe and reliable, engine operation. Also, the increased thermal and aerodynamic loads that have been placed upon compressors, turbines, and combustors require more precise measurement of an increasingly hostile operating environment, component conditions, and engine operation so that superior control may be maintained over the propulsion system operation. Development of advanced high-durability, high-temperature, precision instrumentation will meet these needs. In order for the U.S. to maintain a competitive edge in aeropropulsion, engines will become increasingly complex with higher pressures and temperatures, thus requiring continuing control and instrumentation development.

SPECIFIC OBJECTIVE

TITLE: Engine Systems Research

Program/Discipline Objective Title: Propulsion R&T

Responsible Organization/Individual:
Aeronautical Systems Division/John R. Facey

SPECIFIC OBJECTIVE:

To establish the technology base for advanced general aviation engines with reduced fuel consumption, weight, emissions, broad-specification fuels capability, lower cost and maintenance, and improved reliability; to improve the understanding of propulsion system dynamic behavior and develop engine dynamic prediction techniques; and to investigate the feasibility and potential benefits of new or unusual engine technologies and/or concepts for future military and commercial aircraft.

- General Aviation - Develop intermittent-combustion engine technology base including combustion process modeling, improved cooling techniques, advanced superchargers for spark ignition reciprocating and rotary combustion engines, and diesels.
- Engine Dynamics - Develop and validate analytical methodologies capable of predicting propulsion system dynamic behavior and experimentally investigate systems interactions of advanced components.
- Advanced Engine System Tradeoffs - Evaluate potential of propulsion system concepts and sensitivities for performance, efficiency, durability, weight and cost, to identify technology research requirements and define opportunities for capitalizing on technology advancements.

TARGETS:

- Complete intermittent combustion engine heat transfer codes for combustion chambers - FY 1983.

- Complete the high-bypass engine experimental phase of the stall recovery program - FY 1983.

- Complete initial airflow and combustion system evaluation of an advanced design stratified charge rotary combustion engine - FY 1984.

- Demonstrate design requirements for stratified charge fuel injection systems relative to fuel consumption, emissions, and fuel grade tolerance - FY 1985.

- Complete initial compression system stability models - FY 1986.

JUSTIFICATION:

Engine systems research is being conducted in direct support of technology development for a range of vehicle types from military to general aviation aircraft. Propulsion is a major factor in general aviation safety, fuel efficiency, utility, weight, cost, and environmental compatibility. Improved engines of all types, both conventional and unconventional, are potentially useful as future commuter and general aviation propulsion systems under specific circumstances, including reciprocating spark ignition and diesels, and rotary combustion. Highly maneuverable military aircraft must avoid flow discontinuities and subsequent performance degradation caused by inlet unstarts and compressor stalls. This program is directed toward achieving a better understanding of the dynamic interaction and control phenomena involved in engine operation and providing more reliable theory and prediction techniques to support the evolution of future designs. Another aspect of the program includes analytical investigation of advanced propulsion systems to support national objectives of continued preeminence of U.S. aviation. These investigations provide the continuing evaluation of concepts and techniques for improving the performance of advanced propulsion systems in order to appropriately guide future research efforts.

SPECIFIC OBJECTIVE

TITLE: Propulsion System Test Facility Operations

Program/Discipline Objective Title: Propulsion R&T

Responsible Organization/Individual: Aeronautical Systems Division/John R. Facey (Eng. Sys. Test Fac.) OAST Office of Facilities/Frank Penaranda (Wind Tunnels)

SPECIFIC OBJECTIVE:

To provide safe and productive operations of the wind tunnel and engine test facilities for propulsion systems research at the Lewis Research Center.

- o Operate facilities for propulsion research testing including NASA research and technology and interagency and industrial assistance programs.
  - Wind Tunnels (10x10-foot Supersonic Wind Tunnel, 8x6-foot Supersonic Wind Tunnel, 9x15-foot Low-Speed Wind Tunnel, 6x9-foot Icing Research Tunnel, and 1x1-foot Supersonic Wind Tunnel)
  - Engine System Test Facilities (Propulsion Systems Laboratory, ECR-2 T-700 Facility and the Vertical Lift Fan Facility)
- o Modify propulsion facilities for improved operational safety in order to minimize the risk of personnel injury and facility damage.
- o Modify propulsion facilities for improved efficiency of operation.
- o Repair, replace, or modify, as required, equipment associated with the propulsion facilities to ensure their essential operation.

TARGETS:

- o Conduct, in FY 1983, propulsion related tests in support of appropriate NASA research programs and interagency and industrial programs.
- o Perform, in FY 1983, studies, repairs, replacements, and modifications to the propulsion facilities and associated equipment to assure efficient and safe operation.

- Acquire and install an advanced data acquisition system and peripherals for the propulsion facilities by FY 1984.

JUSTIFICATION:

The propulsion test facilities at the Lewis Research Center are unique in nature and represent a research capability that does not exist anywhere else in the country. Support and operation of these facilities are essential for the conduct of an extensive systems research program and the successful development of future generations of advanced propulsion systems and the continued advancement of the state of the art in aircraft propulsion. This advancement is required to maintain U.S. supremacy in the field of aeronautics. The facilities are essential to provide support, as required, for the basic discipline and systems research and technology programs of the Agency, the developmental programs of the Department of Defense, other Government agencies, and related industrial sponsored programs.

ROTORCRAFT R&T

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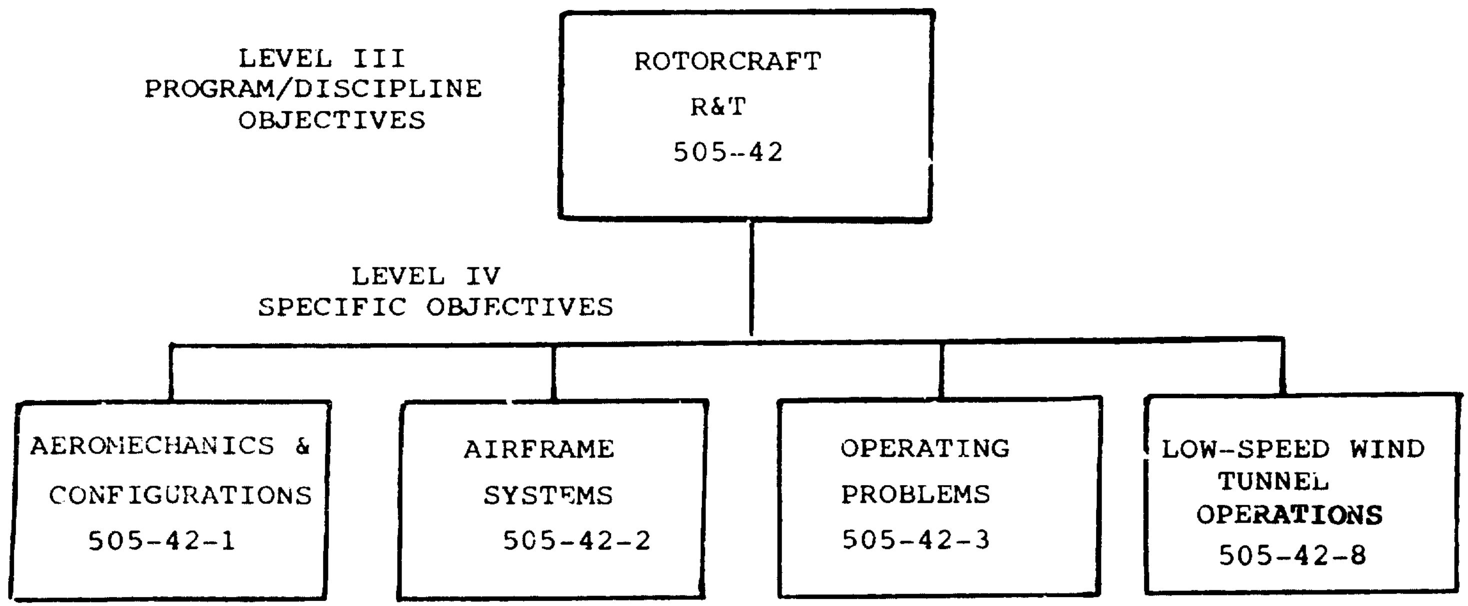
ROTORCRAFT R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



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505-42

PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Rotorcraft R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

PROGRAM/DISCIPLINE OBJECTIVE:

To provide through state-of-the-art advances, improvements in technology areas of rotorcraft structures, dynamics, aerodynamics, acoustics, flight dynamics, controls, avionics, and man-system integration which will provide a technology base for future advances in military and civil rotorcraft vehicles.

SPECIFIC OBJECTIVES:

- Aeromechanics and Configurations: To increase the understanding of rotorcraft applications arising out of state-of-the-art advances in complex computerized prediction, new measurement techniques, electronic cockpit displays, man-machine integration and super-augmented control. To investigate: aerodynamics and aeroacoustics (rotor wakes, local airloads, surface pressure predictions), rotor dynamics (stability, active controls, multi-cyclic control), flight dynamics and control, and handling qualities. To lower the risk of rotorcraft design by providing accurate, correlated prediction methods in performance, loads, and vibration, and in airloads for noise prediction. To provide data for revising airworthiness standards for all-weather and emergency operation.

- Airframe Systems: To investigate promising rotorcraft applications from state-of-the-art advances in materials, complex computerized prediction and new measurement techniques in selected disciplines: structures and materials (designs and usage), acoustics (external noise, internal noise, psychoacoustics), dynamics, loads, and aeroelasticity to increase the understanding of the potential for reduced rotorcraft noise and vibration, and improved structural design.

- o Operating Problems: To advance the technology for solving the unique operating problems of military and civil rotorcraft with particular emphasis on propulsion technology and icing. To address the problems of engine-out operation; engine control; part-power efficiency, power transfer efficiency, reliability, and noise; and the fundamental understanding of rotorcraft icing, with particular attention to the investigation of scaling methodology, performance degradation prediction and verification of analytical methods.

- o Low-Speed Wind Tunnel Operations: To provide safe and productive operations of the wind-tunnel facilities for low-speed aerodynamic and noise research at Ames Research Center.

SPECIFIC OBJECTIVE

TITLE: Aeromechanics and Configurations

Program/Discipline Objective Title: Rotorcraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/George Unger

SPECIFIC OBJECTIVE:

To increase the understanding of rotorcraft applications arising out of state-of-the-art advances in complex computerized prediction, new measurement techniques, electronic cockpit displays, man-machine integration, and super-augmented control. To investigate: aerodynamics and aeroacoustics (rotor wakes, local airloads, surface pressure predictions), rotor dynamics (stability, active controls, multi-cyclic control), flight dynamics and control, and handling qualities. To lower the risk of rotorcraft design by providing accurate, correlated prediction methods in performance, loads, and vibration, and in airloads for noise prediction. To provide data for revising airworthiness standards for all-weather and emergency operation.

TARGETS:

- o Complete validation of a next generation aeroelastic prediction capability for isolated rotor dynamic loads, vibration, and aeroelastic stability using data generated through highly detailed small-scale tests - ARC, FY 1983.

- o Complete the development of a more integrated approach to the investigation of rotorcraft flight dynamics, control handling qualities, human factors, guidance and navigation, and cockpit displays that will lead to a better understanding of how the basic vehicle, the human, the control augmentation, and the information system interact to achieve satisfactory flying characteristics for various mission requirements - ARC, FY 1983.

- o Analyze and test rotorcraft phenomena by completing the following:

  - dynamic stall of an advanced airfoil in plunge - ARC, FY 1983.

- rotor/fuselage/tail/tail rotor interactions, analysis and test - ARC, FY 1983.
- complete 3-D aerodynamic code development, rigid blade, single azimuth cases - ARC, FY 1984.

o Complete small-scale rotor tests measuring airloads in sufficient detail for input to LaRC noise prediction techniques - ARC, FY 1984.

o Complete the investigation of the scaling laws for correlating small-scale tunnel tests and flight test measurements of airloads, noise, and real-world noise effects - ARC, FY 1985.

o Complete development of standard helicopter pilot workload and performance measurement methods - ARC, FY 1985.

o Complete the definition of helicopter minimum control augmentation and display requirements for low-level terrain following military missions - ARC, FY 1985.

JUSTIFICATION:

The development of ultra-high speed computers and new measurement techniques has opened up the promise of accurate prediction methods in the detailed aerodynamic phenomena responsible for noise, vibration, and blade loads. A fully integrated methodology incorporating high mode, coupled structural dynamics, 3-D lifting surface Navier Stokes aerodynamics with free wake modeling and interactions with other surfaces is currently beyond the state-of-the-art. Therefore, the prediction methods currently concentrate on component or isolated parameters to identify ways to reduce noise, vibration and loads, while retaining high performance.

Microprocessor technology has opened up opportunities for light-weight, inexpensive cockpit displays and augmentation systems. Such developments may allow cost-effective operations in difficult rotorcraft tasks such as terrain following and IFR terminal approaches. Opportunities also exist for making major improvements in rotorcraft configurations, such as elimination of the empennage, through the application of "super augmentation" techniques.

SPECIFIC OBJECTIVE

TITLE: Airframe Systems

Program/Discipline Objective Title: Rotorcraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/George Unger

SPECIFIC OBJECTIVE:

To investigate promising rotorcraft applications from state-of-the-art advances in materials, complex computerized prediction and new measurement techniques in selected disciplines: structures and materials (designs and usage), acoustics (external noise, internal noise, psychoacoustics), dynamics, loads, and aeroelasticity to increase the understanding of the potential for reduced rotorcraft noise and vibration, and improved structural design.

TARGETS:

- Complete a feasibility flight test in a joint NASA/Army program of a higher harmonic control system to demonstrate vibration reduction throughout the flight envelope - LaRC, FY 1983.

- Complete development of analysis of coupled rotor/fuselage vibratory response - LaRC, FY 1983.

- Complete the establishment of the feasibility of optimizing blade design for minimizing vibratory loads using tailored stiffness, planform and mass distribution - LaRC, FY 1984.

- Complete the development and validation of a comprehensive design-for-noise capability accurate to $\pm$ 3dB by adding nonlinear terms to the Farassat/Nystrom program for broadband noise modeling - LaRC, FY 1984.

- Complete the development of methods for predicting dynamic stall and tip effects which will lead to more advanced, verified methods for unsteady aerodynamic phenomena due to airfoil pitch and plunge at large scale - LaRC, FY 1985.

- o Complete the quantification of the effects of long-term flight exposure on the strength of secondary Kevlar structures - LaRC, FY 1987.

JUSTIFICATION:

The development of composite materials, ultra-fast computers, micro-electronics, and new measurement techniques has opened up new opportunities for quantum improvements in rotorcraft vibration, external noise, and durable, lightweight structures. Vibration and external noise seriously compromise the acceptance and economic utility of both military and civilian rotorcraft. For the rotor system, the use of composites in blade manufacture allows specific tailoring of design parameters that can reduce vibration and noise. It now appears possible to optimize the design of a composite blade in a cost-effective manner. In addition, the use of micro-processors and high-speed actuators now allows higher harmonic control of blade pitch that promises even greater reductions in vibration as well as active control for gust alleviation, performance enhancement, noise control, etc.

In the fuselage, the application of thin gauge composites is unique to rotorcraft and merits a long-term evaluation of the strength degradations on an operating helicopter. Such work should lead to the confident specification of such materials in primary structures where weight, crashworthiness, and durability (corrosion) are important.

SPECIFIC OBJECTIVE

TITLE: Operating Problems

Program/Discipline Objective Title: Rotorcraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Jeffrey H. Godfrey

SPECIFIC OBJECTIVE:

To advance the technology for solving the unique operating problems of military and civil rotorcraft with particular emphasis on propulsion technology and icing. To address the problems of engine-out operation; engine control; part-power efficiency; power transfer efficiency, reliability, and noise; and the fundamental understanding of rotorcraft icing with particular attention to the investigation of scaling methodology, performance degradation prediction and verification of analytical methods.

TARGETS:

- o Complete initial studies of engine contingency power options - LeRC, FY 1983.
- o Complete initial tests using OH-58 tail rotor testing rig in the 9x6-ft. Icing Research Tunnel - LeRC, FY 1983.
- o Complete initial series of icing tests to build data base for iced-airfoil aerodynamic characteristics applicable to rotor performance prediction analyses - LeRC, FY 1984.
- o Complete helicopter flight tests utlizing Ottawa Spray Rig to obtain performance and ice shape data - LeRC, FY 1984.
- o Complete the replication of ice shapes from flight tests and complete full-scale 2-D airfoil tests in dry transonic wind tunnel - LeRC, FY 1984.

- o Complete initial hydromechanical controls tests utilizing the T700 Engine Test Bed - LeRC, FY 1984.
- o Complete inhouse feasibility assessments of advanced power transfer concepts that offer advantages, such as: improved maintainability, reliability, system efficiency, and reduced noise for the next generation of advanced rotorcraft - LeRC, FY 1984.

JUSTIFICATION:

Military and civil operators have high-priority needs relative to rotorcraft propulsion systems. Two areas of almost universal concern are reliability and the need for a true single-engine contingency power rating. Excessive transmission noise within the crew/passenger compartment is another area requiring attention. In addition, the ability to assure safe operation in the event of forecast icing conditions is absolutely essential to achieve truly "all-weather" operation capability.

505-42-8

SPECIFIC OBJECTIVE

TITLE: Low-Speed Wind Tunnel Operations

Program/Discipline Objective Title: Rotorcraft R&T

Responsible Organization/Individual: OAST Office of Facilities/Frank Penaranda

SPECIFIC OBJECITVE:

To provide safe and productive operations of the wind tunnel facilities for low-speed aerodynamic and noise research at Ames.

- o Support experimental research to provide baseline data for the development of accurate prediction methods for vehicle performance, stability, and control in low-speed flight, V/STOL aerodynamics, and rotorcraft aeromechanics.
- o Support research into aircraft noise generation and its effects in relation to aircraft design.
- o Maintain, operate, and improve the Static Test Facility and the 7x10-ft. wind tunnel.
- o Support the 40x80/80x120-ft. operational check-out, data systems readiness, and bring the test complex to operational status.

TARGETS:

- o Support low-speed aerodynamic and noise wind tunnel testing at Ames.

JUSTIFICATION:

Research on low-speed aerodynamics for all aircraft is essential. Precise prediction methods, especially for maximum lift, drag, V/STOL aerodynamics, and rotocraft aeromechanics are not available and will not be in the foreseeable future. It is therefore necessary to conduct

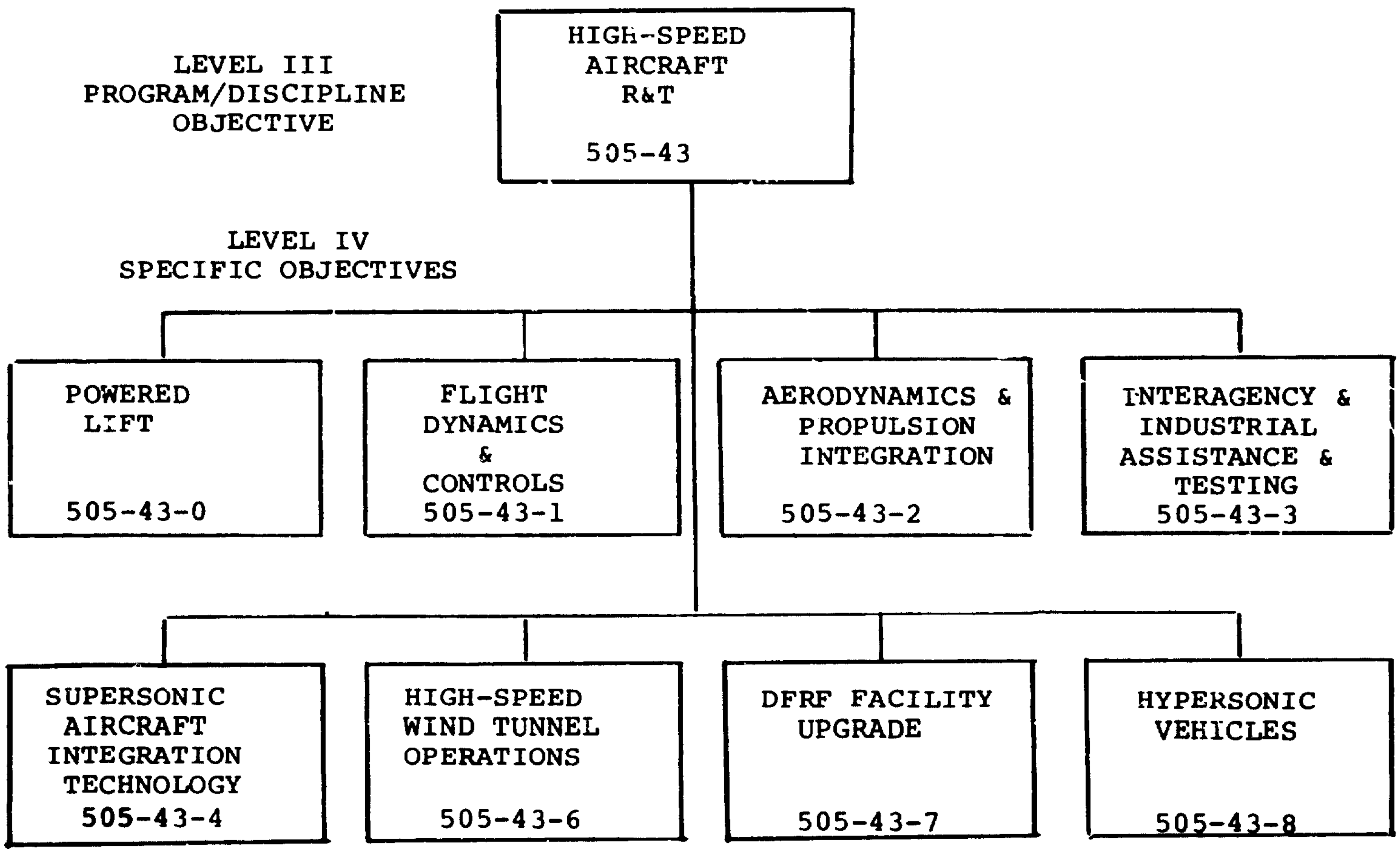
experimental research both to provide answers and to provide data for the development of accurate prediction methods. In many of these problems, the need to match Reynolds number, Mach number, structural dynamics, or propulsion parameters dictates full- or large-scale experiments in the 40x80/80x120-ft. complex.

With the recent concentration on maintaining a quality environment, and resultant civil regulations, noise has become as important a parameter in airplane design as is aerodynamics. Recent research has shown that configuration effects on noise generation are substantial, and thus noise research has become an important segment of low-speed aircraft research programs.

HIGH-SPEED AIRCRAFT R&T

HIGH-SPEED AIRCRAFT R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: High-Speed Aircraft R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aeronautical Systems Division/Jack Levine

PROGRAM/DISCIPLINE OBJECTIVE:

To evolve and explore advanced concepts for future high-speed aircraft, generate improved analytical prediction methods and experimental data for DOD/industry use, and directly support DOD and other Government agencies.

SPECIFIC OBJECTIVES:

- Powered Lift: To provide the unique analytical methods, advanced experimental test techniques, and the technology base in the areas of aerodynamics, propulsion, configuration integration and flight dynamics required for the development of effective high-performance powered-lift aircraft including both vertical/short takeoff and landing (V/STOL) and short takeoff and landing (STOL).

- Flight Dynamics and Controls: To develop a better understanding of basic phenomena, improved analytical and experimental techniques, new concepts, and valid experimental data related to dynamics and handling qualities characteristics of high-speed aircraft, and to develop integrated airframe/propulsion control system technology essential for future high-speed aircraft.

- Aerodynamics and Propulsion Integration: To develop, through analytical and experimental studies and tests, an aerodynamics and propulsion integration technology data base for advanced configuration concepts applicable to the design of improved future high-speed airplanes and missiles.

- Interagency and Industrial Assistance and Testing: To provide technical assistance, consultative services, and support, through the use of NASA facilities, to other Government agencies and the airplane/missile industry.

- Supersonic Aircraft Integration Technology: To develop a technology data base for high-speed military and civil aircraft design concepts incorporating improved aerodynamic performance, advanced configurations, high-temperature materials and structures, and propulsion system/airframe integration techniques.

- High-Speed Wind Tunnel Operations: To provide support and operations of the high-speed wind-tunnels at Ames Research Center and flight vehicle support for required chase planes, flight-readiness flying, remotely-piloted vehicle drops, and other support activities at the Dryden Flight Research Facility.

- DFRF Facility Upgrade: To provide safe and productive acquisition of flight research data.

- Hypersonic Vehicles: To perform a program of applied research to develop key technologies for application in air-breathing aircraft and missiles in the Mach 3-8 flight regime.

SPECIFIC OBJECTIVE

TITLE: Powered Lift

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Gordon Banerian

SPECIFIC OBJECTIVE:

To provide the unique analytical methods, advanced experimental test techniques, and the technology base in the areas of aerodynamics, propulsion, configuration integration and flight dynamics required for the development of effective high-performance powered-lift aircraft including both vertical/short takeoff and landing (V/STOL) and short takeoff and landing (STOL).

- o Improve and validate powered-lift flow and performance prediction methods and test techniques.
- o Improve the lift/thrust performance and control vectoring of powered-lift propulsive systems for the diverse operating environment of STOL and V/STOL flight.
- o Evaluate flight control systems, display concepts, and flight test and simulation modeling ship- and land-based V/STOL aircraft.
- o Provide a data base for powered-lift aircraft configuration and propulsion system integration through selected small- and large-scale powered model investigations.
- o Provide computational and experimental support for cooperative NASA/Navy powered-lift technology development activities as mutually agreed upon and funded by the Navy and Air Force.

TARGETS:

- o Incorporate the compact multimission aircraft propulsion simulator into a small-scale fighter aircraft model. (ARC) FY 1984

- o Complete the high-speed aerodynamic characteristics of four twin-engine powered-lift configurations and two single-engine V/STOL fighter models through wind-tunnel tests with flow-through nacelle models. (ARC) FY 1984

- o Complete powered-lift thrust modulation by variable pitch fan blades and variable inlet guide vanes on 20-inch diameter subsonic V/STOL propulsion model. (LeRC) FY 1984

- o Examine the aerodynamic and simulated flight characteristics of a subsonic twin tilt nacelle utility V/STOL design. (ARC) FY 1984

- o Develop general criteria from ground-based simulation for design of control and display concepts to provide V/STOL handling qualities. (ARC) FY 1984

- o Evaluate the transition and hover characteristics of a V/STOL fighter configuration using a fuselage ejector. (ARC) FY 1985

- o Examine the transition characteristics of aircraft with swept forward wings and powered lift. (ARC) FY 1985

- o Evaluate design criteria for optimized use of propulsion integrated in a supercruiser configuration concept for high lift, thrust reversing/vectoring and longitudinal trim control through test of a modest-scale powered model. (LeRC) FY 1985

- o Evaluate a stealthy supersonic powered-lift inlet and nozzle concept through 12-inch diameter propulsion model test. (LeRC) FY 1985

- o Develop advanced computational methods for V/STOL inlet flow fields, forebody/inlet interactions, and propulsion induced effects. (ARC) FY 1985

- o Provide design methodology for predicting aerodynamic characteristics of V/STOL aircraft in transition flight and while hovering in and out of ground effect. (ARC) FY 1986

JUSTIFICATION:

The great value of V/STOL flight capability in both the civil and military marketplace is well demonstrated by the growing use of helicopters, and though the Harrier and Freehand aircraft programs in the U.S. and abroad. The Navy is striving to realize the potential of additional powered-lift aircraft types to greatly increase its sea-based air effectiveness. The Air Force has interest in the use of powered lift for a number of requirements, with particular attention to runway denial situations. However, the technical difficulties in overcoming the inherent vehicle penalties associated with providing STOL and V/STOL flight capability (which tend to become greater as aircraft design speed and range increase) have been important factors in stalling powered-lift aircraft development programs.

NASA-conceived and conducted R&T Base powered-lift programs have had a large part in forming the technology base for the recent growing military interest in powered lift. NASA must continue a strong powered-lift base program in order to attain markedly improved computational and experimental techniques specifically oriented to the unique needs of powered lift.

SPECIFIC OBJECTIVE

TITLE: Flight Dynamics and Controls

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Richard J. Wasicko

SPECIFIC OBJECTIVE:

To develop a better understanding of basic phenomena, improved analytical and experimental techniques, new concepts, and valid experimental data related to dynamics and handling qualities characteristics of high-speed aircraft, and to develop integrated airframe/propulsion control system technology essential for future high-speed aircraft.

- o Formulate improved analytical/experimental techniques for estimating the flight dynamics and handling qualities characteristics of high-speed aircraft in important flight regimes, including high angle-of-attack and stall/spin conditions.

- o Develop new configuration and systems concepts for achieving desired flight dynamics and handling qualities characteristics without significant aircraft performance penalties.

- o Perform appropriate wind-tunnel and other ground facilities tests to establish a valid experimental data base on advanced high-speed aircraft flight dynamics characteristics.

- o Determine desired airframe/propulsion control system architectures for advanced high-speed aircraft.

- o Perform appropriate integrated airframe/propulsion control system ground facility validation research and assess flight test/technology demonstration requirements

TARGETS:

- o Complete, in FY 1983, initial investigations of the application and use of thrust vectoring on high-speed aircraft.

- o Complete, in FY 1983, investigations of different system architectures having various degrees of integration, including assessments of benefits and disadvantages in terms of cost, maintainability, reliability, and other key factors.

- o Complete, by FY 1985, analytical, wind-tunnel and simulator studies of thrust vectoring and in-flight thrust reversing on high-speed aircraft configurations.

- o Complete, by FY 1986, ground facility validation research tests of an advanced integrated airframe/propulsion control system.

JUSTIFICATION:

The flight dynamics and handling qualities of high-speed aircraft have significant influence on the aircraft's usefulness, efficiency, and safety in actual operations. Continued development of a fundamental understanding and improved basic analytical and experimental techniques are essential to establish a strong foundation for future aircraft developments. The trend of increased application of active controls technology to a variety of aircraft systems capabilities emphasizes the need for and timeliness of developing advanced techniques and a valid data base for achieving desirable response and handling behavior. Improved analytical and experimental techniques and new configuration concepts are also needed so that future aircraft can be designed with desired spin resistance or recovery characteristics.

For most future high-speed aircraft concepts, coupling/integration of airframe and propulsion control functions will be essential. For example, high-performance fighter aircraft with vectoring and reversing two-dimensional nozzles can have the pilot's control stick and rudder pedals commanding nozzle movements as well as aerodynamic surface movements. Strategic aircraft concepts for low radar and infrared signatures may achieve yaw stability and control by modulating vanes or other devices integral to the propulsion system. Highly optimized supersonic cruise aircraft also may have significant airframe and propulsion control integration to obtain the desired and necessary maximum flight efficiency. It is essent al, therefore, to determine and validate the best overall fully integrated digital airframe/propulsion control system which will be required to allow successful development of these promising future high-speed aircraft concepts.

SPECIFIC OBJECTIVE

TITLE: Aerodynamics and Propulsion Integration

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Richard J. Wasicko

SPECIFIC OBJECTIVE:

To develop, through analytical and experimental studies and tests, an aerodynamics and propulsion integration technology data base for advanced configuration concepts applicable to the design of improved future high-speed airplanes and missiles.

- o Formulate advanced concepts for improved supersonic cruise and maneuver capability of combat airplanes and missiles.
- o Conduct wind-tunnel and ground-facility tests of advanced aerodynamic configurations, inlet designs, and nozzle concepts over a wide range of speeds, from subsonic to transonic and supersonic, and at simulated combat operating conditions.
- o Formulate and test improved methods of integrating missiles with the carrying aircraft and achieving high-speed release.
- o Perform selected aerodynamic experiments to obtain data and improve techniques for the comparison of theoretical predictions with ground and flight test results.

TARGETS:

- o Complete, in FY 1983, ground facility tests of the ADEN nonaxisymmetric nozzle on an F404 engine.
- o Complete, in FY 1983, the initial design iteration process for advanced supersonic tactical airplane configurations.
- o Develop, by FY 1984, the aerodynamic technology base for the design of monoplanar missiles with high-speed cruise and maneuver capability.
- o Initiate, by FY 1985, ground facility tests of a high-aspect-ratio nonaxisymmetric nozzle.

- o Establish, by FY 1985, an aerodynamic technology data base for efficient weapons integration, carriage, and separation at supersonic speeds.

- o Develop, by FY 1986, a unified wing design rationale for the tradeoff of optimum features at different speeds, subsonic-transonic-supersonic, for highly maneuverable combat aircraft.

JUSTIFICATION:

NASA has maintained pre-eminence in the formulation of advanced concepts for aerodynamic configurations and inlet/nozzle propulsion integration for combat airplanes and missiles far in advance of the specific needs of the military services which eventually apply these concepts. Thus, when military planners establish the need for new advanced capabilities in combat airplane or missile systems, an extensive source of verified experimental data is available for incorporation into the preliminary designs generated by industry and for the use of the military services in the system selection process. Continued effort is needed to evolve and test unique new concepts which further improve the high-speed performance and maneuverability of combat airplanes and missiles as well as to better integrate the two for overall system effectiveness. Numerous cooperative efforts have existed and will continue to exist with the Air Force, Navy, and Army involving NASA technical expertise and unique facilities in the planning, selection, and development of innovative combat airplane and missile designs leading to improved systems capabilities. In this way, NASA is able to transfer new ideas and concepts into emerging designs and, at the same time, achieve a realistic understanding of developmental problems which eventually lead to further improvements.

505-43-3

SPECIFIC OBJECTIVE

TITLE: Interagency and Industrial Assistance and Testing

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Richard J. Wasicko

SPECIFIC OBJECTIVE:

To provide technical assistance, consultative services, and support, through the use of NASA facilities, to other Government agencies and the airplane/missile industry.

- o Assist the Department of Defense (DOD) on airplane and missile development programs in response to their requests to NASA; conduct joint activities with other Government agencies; and respond to industry requests on a fee or reimbursable basis, or as joint research activities.
- o Conduct ground facility and flight tests at Ames, Langley and Lewis Research Centers on developmental models of airplanes and missiles on a specific request basis.
- o Utilize NASA wind tunnels, simulators, and computational capabilities toward the solution of developmental airplane and missile problems.
- o Provide NASA expert participation on ad hoc groups, boards, etc. for the technical evaluation of developing airplanes and missile concepts.
- o Consider and utilize, when appropriate, inputs and information derived from interagency and industrial assistance programs to assist in establishing priorities for NASA research programs.

TARGETS:

- o Conduct, in FY 1983, experimental investigations augmented by theoretical analyses to support current DOD airplane and missile development programs, as well as those identified in future requests.

- Provide, in FY 1983, consultative services and technical assistance to DOD, as requested, on current and future development programs such as the B-1, F-16, F-18, AV-8B, NGT and other aircraft.

- Provide, in FY 1983, technical assistance and facilities support to other Government agencies and the airplane/missile industry, on a specific request basis, to achieve improved future systems.

JUSTIFICATION:

The Department of Defense needs and requests NASA assistance on most major military aeronautical development programs to perform tests in unique NASA facilities, to conduct urgent tests that the DOD is unable to accomplish in its facilities, and to provide technical consultation. The main thrust of this assistance is to help DOD evaluate and improve specific military systems in the current inventory or under active development in order to establish and maintain U.S. pre-eminence in military activities. The activities and tests provide a substantial amount of design information and analyses which permits the DOD and its contractors to make sound decisions toward realizing critical development milestones and achieving safe, reliable, and higher performing aircraft of the future. This assistance to DOD, and other activities in support of the airplane/missile industry and other Government agencies, provides NASA with the important benefit of a better definition of problem areas requiring more basic research and a better awareness of the practical problems involved in applying new aeronautical technologies.

505-43-4

SPECIFIC OBJECTIVE

TITLE: Supersonic Aircraft Integration Technology

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Jack A. Suddreth

SPECIFIC OBJECTIVE:

To develop a technology data base for high-speed military and civil aircraft design concepts incorporating improved aerodynamic performance, advanced configurations, high-temperature materials and structures and propulsion system/airframe integration techniques.

- o Establish a supersonic aerodynamics technology base that permits improvement in L/D, reduction in drag, refinement of aircraft concepts, and optimization of aircraft characteristics over the full operating speed range.
- o Evolve and refine advanced military and civil aircraft configurations that provide advancements in performance, range, speed, volume, boom signature, fuel consumption, etc.
- o Establish a high-temperature structures and materials technology base that permits significant reductions in structural weight by research on new materials, structural design, and fabrication techniques providing satisfactory fatigue, fracture, and thermal/cyclic life characteristics under high-speed flight conditions.
- o Establish an inlet/engine/nozzle/airframe integration data base and evolve design procedures and methodology for the installation and control of advanced multi-variable systems on high-speed aircraft.

TARGETS:

- o Complete the supersonic leading-edge thrust model studies begun in the SCR program. FY 1983
- o Complete the generic high-lift/low-speed leading-edge devices study begun in the SCR program. FY 1983

- o Complete the fabrication and initiate the test program on the variable diameter center body inlet. FY 1983

- o Initiate a fiber-reinforced SPF/DB titanium structural characterization/fabrication technology program. FY 1983

- o Complete assessment of SCR technologies applicable to advanced military aircraft concepts. FY 1983

JUSTIFICATION:

Achievement of high performance and efficiency in supersonic aircraft forces the design to apply sophisticated aerodynamics, unique configurations lightweight structures, and the careful integration of all subsystems to achieve a given level of performance or a mission capability. Work on this specific objective allows for the beneficial interaction of advanced technology to provide improved high-speed aircraft performance. The aerodynamics technology will continue analytical and experimental work on wing twist and camber, leading-edge shape and contour, sweep angle and planform, all directed at improved aerodynamic performance.

Aircraft configuration efforts are aimed at evolution of advanced concepts incorporating specific aircraft features such as long range, high density, maximum volume, low sonic boom or extremely light weight for application to future military or civil aircraft requirements.

High-speed structures technology is directed to characterization of advanced high-strength, low-weight composite and titanium materials capable of operation at elevated temperatures. Weight reduction and fabrication improvements are being developed through use of improved resin/fiber composites and titanium. Refinement of computational procedures provides the methodology for aerodynamic loads, structural design, and weight optimization.

Integration of functions and subsystems is often configuration-peculiar, but for the near term the most complex and most demanding area is the propulsion system/airframe integration area. The NASA efforts are directed to data base acquisition on inlet, nozzle, aerodynamic flow-field effects and control.

505-43-6

SPECIFIC OBJECTIVE

TITLE: High-Speed Wind Tunnel Operations

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: OAST Office of Facilities/Frank Penaranda

SPECIFIC OBJECTIVE:

To provide support and operations of the high-speed wind tunnels at the Ames Research Center and flight vehicle support for required chase planes, flight-readiness flying, remotely-piloted vehicle drops, and other support activities at the Dryden Flight Research Facility.

- o Operate the high-speed wind tunnels (11-ft., 9x7-ft. and 8x7-ft. Unitary Plan Tunnels; 12-ft. pressure tunnels; 2x2-ft. and 14-ft. transonic tunnels; and 6x6-ft. supersonic tunnel) for aerodynamic tests including NASA research and technology programs and inter-agency and industrial assistance programs.
- o Modify the high-speed wind-tunnel facilities for improved operational safety in order to minimize the risk of personnel injury and facility damage.
- o Modify the high-speed wind-tunnel facilities for improved efficiency of operations.
- o Repair, replace or modify, as required, equipment associated with the high-speed wind tunnels to ensure their essential operation.
- o Provide flight support for high-performance manned vehicle flight programs such as the F-14 High Angle-of-Attack Testing, AFTI F-111 Mission Adaptive Wing Technology, and AFTI F-16 Envelope Expansion Tests.

- o Provide flight support for other research programs such as Jetstar Turboprop Tests, Wake Vortex Minimization, F-8 Digital Fly-By-Wire, and AD-1 Oblique Wing Tests.

TARGETS:

- o Conduct aerodynamic tests in the high-speed wind tunnels to support appropriate NASA research programs and to assist the Department of Defense and other Government agencies, and the aircraft industry.

- o Perform studies, repairs, replacements, and modifications to the high-speed wind-tunnel facilities and associated equipment to ensure efficient and safe operation.

- o Support principal flight research programs and experiments.

JUSTIFICATION:

The high-speed wind-tunnel facilities at the Ames Research Center are of a unique nature and represent a capability that does not exist anywhere else in the country. Support and operation of these wind tunnels is essential to the successful advancement of the state of the art in aerodynamics technology to enable the development of future civil and military aircraft and to maintain U.S. preeminence in aeronautics. The high-speed wind tunnels are essential to provide support, as required, for the basic research and technology programs of the Agency, the Agency's vehicle-specific programs, the developmental programs of the Department of Defense and other Government agencies, and the company-sponsored programs of the aircraft industry.

Flight research programs and experiments at the Dryden Flight Research Facility require readiness training and chase/drop/communications aircraft support to adequately carry out safe, efficient, high-quality research. The work done under this specific objective provides that flight research support.

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505-43-7

SPECIFIC OBJECTIVE

TITLE: DFRF Facility Upgrade

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: OAST Office of Facilities/Frank Penaranda

SPECIFIC OBJECTIVE:

To provide safe and productive acquisition of flight research data.

TARGET:

- To provide support of approved facility upgrading to DFRF including the Flight Loads Facility and the Data Analysis Facility.

JUSTIFICATION:

Flight test of advanced aeronautical vehicles requires highly productive ground-based and fli data systems. The productivity of such systems is dependent on the rapid acquisition of accurate data from carefully planned and executed flights of research aircraft. Important precursor activities include accurate calibration of flight instrumentation, including flight loads measurement systems. In addition, advanced simulation techniques may be coupled to increase the productivity of high-risk flight investigations.

SPECIFIC OBJECTIVE

TITLE: Hypersonic Vehicles

Program/Discipline Objective Title: High-Speed Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Jack A. Suddreth

SPECIFIC OBJECTIVE:

To perform a program of applied research to develop key technologies for application in air-breathing aircraft and missiles in the Mach 3-8 flight regime.

- o From a wide range of vehicle types, identify the technology barriers in need of concentrated effort.
- o Provide experimental techniques, analytical methods, and fundamental aerodynamic data base needed to permit the efficient design of future supersonic/hypersonic vehicles.
- o Develop and evaluate, with appropriate experiments, advanced structural concepts for hypersonic airframes and engines.
- o Establish a data base of performance and operational characteristics for advanced supersonic/hypersonic propulsion concepts and related components.

TARGETS:

- o Develop, in FY 1983 improved analysis techniques for determining the aerodynamic characteristics of complete vehicle concepts.
- o Develop, through analytical and experimental methods, design techniques applicable to the propulsion/airframe integration area for this class of vehicle. FY 1983
- o Validate analytical predictions with ground tests of propulsion systems, configurations (i.e., wind-tunnel models), and structural components, the technology options for hypersonic airbreathing missiles. FY 1984
- o Develop effective structural concepts for an airframe and a hydrocarbon scramjet for a hypersonic missile by end of FY 1986.

- o Demonstrate fabricability and determine thermal/structural performance of practical hydrogen-cooled scramjet by end of FY 1986.

JUSTIFICATION:

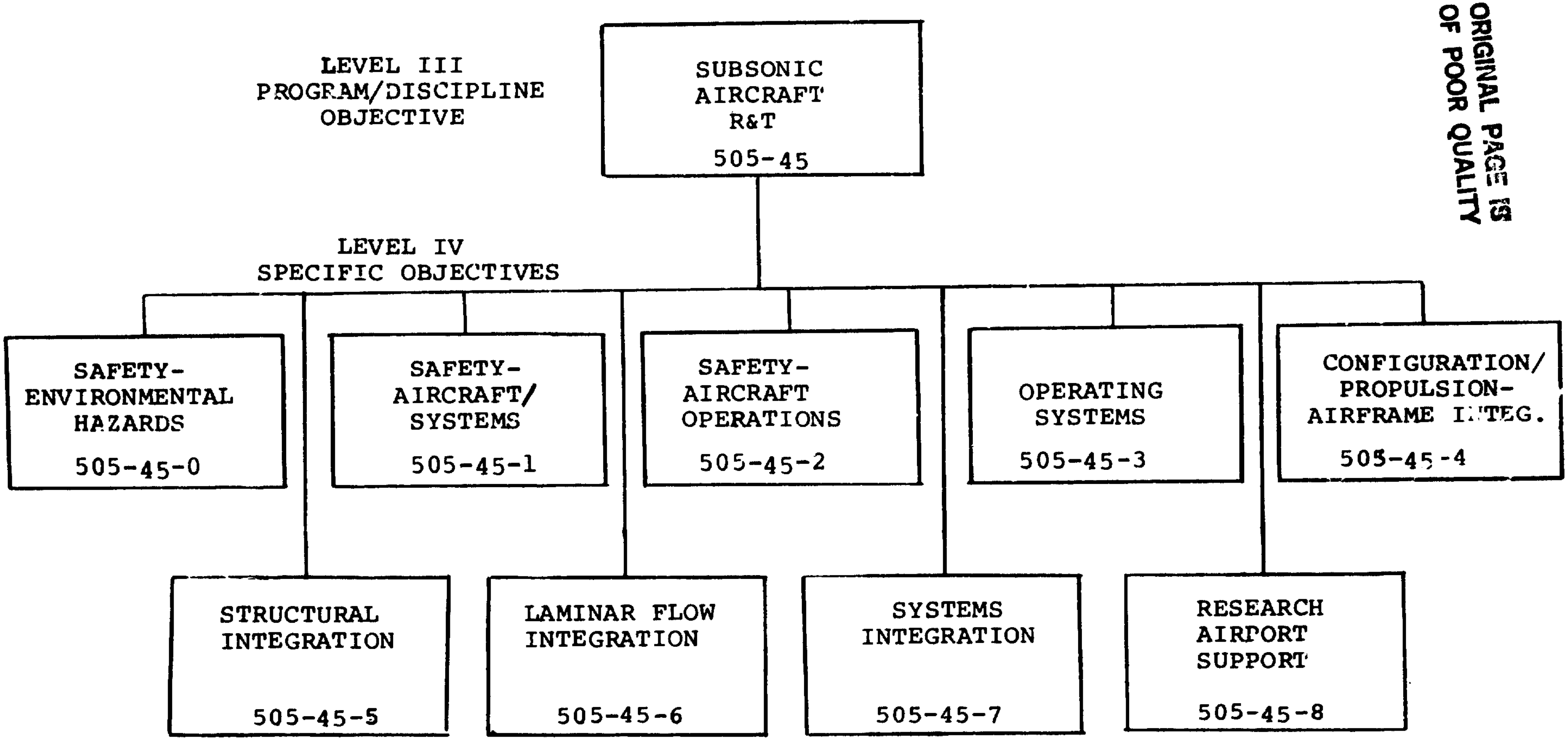
Technology developed by this program will provide the United States with advanced aircraft and missile options important to future military needs. Aircraft operating at hypersonic speeds and high altitudes offer the potential of increased lethality and higher levels of survivability in military missions. Airbreathing propulsion missiles capable of hypersonic speeds offer longer range with short flight time that open a new class of mission capability previously difficult or impossible to achieve with rocket powered missiles. NASA and the U.S. Navy have a cooperative program in technology for advanced fleet defense missile technology.

SUBSONIC AIRCRAFT R&T

13

SUBSONIC AIRCRAFT R&T WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Subsonic Aircraft R&T

Program Area Title: Research and Technology Base

Responsible Organization/Individual: Aeronautical Systems Division/Roger L. Winblade

PROGRAM/DISCIPLINE OBJECTIVE:

To provide in the general area of subsonic aircraft, the necessary systems research and concept development to provide an improved and validated base of new technology for application by industry to future generations of the entire spectrum of civil/military aircraft.

SPECIFIC OBJECTIVES:

- Safety - Environmental Hazards: To provide a better understanding of atmospheric processes and how they affect the design and safe, efficient operation of aircraft and component systems.

- Safety - Aircraft/Systems: To develop a continuum of technology which can be applied to reduce aviation accident opportunities and to minimize the fatalities and damage resulting from accidents.

- Safety - Aircraft Operations: To examine new concepts and techniques which offer potential for reducing both operational complexities and costs of aircraft systems with a view toward safe use of the improved systems by large and small civil aircraft.

- Operating Systems: To define functional requirements and performance criteria for flight systems and displays of the future with which the pilot can safely and effectively operate in the evolving National Airspace System; to perform more efficient flight with respect to fuel, airspace, and time; to increase traffic flow capacity; and to improve the operational capability in adverse weather.

- Configuration/Propulsion-Airframe Integration: To provide the advanced technology base, design methodology and analytical codes for subsonic aircraft to improve safety and efficiency, lower cost, and reduce integration losses that are associated with integrating propulsion systems with the airframe.

- Structural Integration: To develop a composites design and analysis data base and qualification procedures for safety-of-flight, strength-critical advanced composite structure.

- Laminar Flow Integration: To develop and demonstrate practical, reliable, and maintainable laminar flow technology for application to future civil and military aircraft.

- Systems Integration: To exploit the potential benefits to be derived from the systems integration of advanced electric power, active controls and digital electronic technologies for aerospace application.

- Research Airport Support: To provide support costs associated with aeronautics programs that use the facilities of the Wallops research airport and other supporting services.

505-45-0

SPECIFIC OBJECTIVE

TITLE: Safety - Environmental Hazards

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Allan R. Tobiason

SPECIFIC OBJECTIVE:

To provide a better understanding of atmospheric processes and how they affect the design and safe, efficient operation of aircraft and component systems.

- o Characterize wind shear, high-altitude clear-air turbulence, severe storm outflows, and low-altitude turbulence in utilitarian terms.
- o Characterize atmospheric electrical phenomena.
- o Develop improved procedures for aircraft operations in the vicinity of storms.
- o Advance the technology related to the safe operation of aircraft in atmospheric icing conditions.
- o Identify advanced meteorological instrumentation technology needs unique to airborne research and operational systems.

TARGETS:

- o Measure spanwise gust gradients encountered in terminal-area operations, in support of flight simulation studies and updated gust design criteria for large aircraft - FY 1982-1983
- o Investigate high-altitude clear-air turbulence avoidance concepts using passive microwave techniques - FY 1983
- o Develop computational methods and study modern airfoil performance under icing conditions - FY 1983-1985

- Evaluate and develop instrumentation for characterizing natural icing and aircraft ice detection - FY 1983-FY 1985
- Explore effectiveness of new and improved ice protection concepts for fixed- and rotary-wing aircraft - FY 1983-1985
- Correlate icing and dry research tunnel results with icing flight data from Twin Otter icing flight program - FY 1983-1985
- Collect direct lightning strike and turbulence in convective storms data with F-106 - FY 1983-1984
- Determine aerodynamic penalties of heavy rainfall - FY 1983
- Continue support of interagency wind shear research (JAWS) - FY 1983
- Conduct field program for warm fog dispersal - FY 1983
- Conduct Government-Industry Meteorology Workshop and Interagency Meteorology Retreat - FY 1983-FY 1985

JUSTIFICATION:

It is necessary to develop technology based on improved knowledge of atmospheric processes to be able to: (1) predict hazards for aircraft operations; (2) define hazards so as to enable possibly "designing out" their adverse effects on future airplanes or airports or to improve hazard avoidance; (3) simulate hazards so as to determine if they were causative factors in aircraft accidents and to train pilots to cope with atmospheric anomalies; and (4) eliminate or reduce hazards by modification of the warm fog environment. This technology development is an important element in the design of aircraft and aviation facilities and the safe operation of aeronautical systems.

This Specific Objective is to be coordinated closely with NASA's Office of Space Science and Applications' Meteorology programs to insure the maximum possible cooperation and program synergism. Similarly, NOAA, FAA, and DOD Meteorological efforts must be taken into account through the Office of the Federal Coordinator for Meteorology, to avoid unnecessary duplicative effort.

SPECIFIC OBJECTIVE

TITLE: Safety - Aircraft Systems

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Allan R. Tobiason

SPECIFIC OBJECTIVE:

To develop a continuum of technology which can be applied to reduce aviation accident opportunities and to minimize the fatalities and damage resulting from accidents.

TARGETS:

- o Develop fire modeling techniques for fire spread heat and gas release which can be used in preventive design, test methods and accident investigation - FY 1983-1984
- o Complete reports on DVGH as a data base for knowledge of the usage of various types of aircraft relative to their original design criteria using current and advanced on-board data recorders - FY 1983
- o Provide technical support and RPV controls for NASA-FAA FY 1984 crash of a large jet transport to validate AMK, and measure crash impact dynamics - FY 1983-1984
- o Continue development of lightweight advanced fire-worthy cabin interior materials - FY 1983-1984
- o Continue development of human survivability model in post-crash fire accidents using previously developed fire scenarios, cabin interior materials performance and human tolerance criteria - FY 1983
- o Determine and optimize design parameters which, taking advantage of new fireworthy materials, AMK, and various modeling capabilities, can greatly reduce the likelihood of in-flight, post-crash, and ramp aircraft fires - FY 1983-1984

- o Develop improved equipment, techniques, and criteria for aircraft operations in wind shear, heavy rain, and turbulence for improved flight control - FY 1983-1984

- o Establish the technology for providing improved protection of aircraft and systems from severe storm hazards to include lightning, turbulence and wind shear - FY 1983-1984

- o Analyze ASRS data base for safety research opportunities requiring unique NASA expertise in safety research - FY 1983

- o Provide on an ad hoc basis, unique NASA expertise and capabilities to support National Transportation Safety Board (NTSB) in accident investigation and analyses - (Continuing)

JUSTIFICATION:

Aircraft safety research is necessary to provide a technology base which can be used to reduce accident circumstances and to minimize the consequences of accidents which inevitably occur. Solutions to aircraft operating problems and the causes of accidents require a new level of knowledge and understanding of the hazard and its disenabling factors. The effects of employing different solutions must be considered in order to avoid creating additional problems. The majority of the research is conducted cooperatively with FAA.

SPECIFIC OBJECTIVE

TITLE: Safety - Aircraft Operations

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Allan R. Tobiason

SPECIFIC OBJECTIVE:

To examine new concepts and techniques which offer potential for reducing both operational complexities and costs of aircraft systems with a view toward safe use of the improved systems by large and small civil aircraft.

- Advance the technology for safe, economical all-weather aircraft ground operations, including the development of new landing system concepts.
- Develop interactive software to provide rapid and accurate subsynoptic meteorology information for use in air traffic control and fuel-efficient flight planning.

TARGETS:

- Determine operating characteristics of braking systems - FY 1983
- Develop analytical tire model - FY 1983
- Evaluate thermal effects on tire carcass strength - FY 1983
- Define the dynamics and effects on aircraft/runway performance of blown tires and failed wheels - FY 1983
- Continue tire behavior studies and design optimizations - FY 1983-1985
- Continue update of aircraft landing dynamics facility - FY 1983-1984
- Initiate engine spray ingestion research - FY 1983

- o Advance antiskid system development - FY 1983-1984
- o Conduct ground tests of an advanced air cushion landing system - FY 1983-1984
- o Complete modified flight simulator for research on aircraft ground operational problems - FY 1983
- o Develop and validate software simulation of active control landing gear behavior - FY 1983
- o Conduct cooperative research with FAA to validate prediction theory of aircraft stopping performance on nonstandard runway surfaces - FY 1983
- o Develop interactive techniques to combine complementary fine-scale winds/temperature data sets for optimum flight planning and ATC interfaces - FY 1983-1984
- o Support NTSB accident investigations using unique expertise and facilities - (Continuing)

JUSTIFICATION:

Research related to improvement of aircraft systems efficiency has direct relevance to the OAST emphasis on strengthening the aeronautical R&T base. Since all aircraft types and the ATC system benefit by improvements in aircraft systems efficiency, this program lends strong support to many other NASA and FAA aviation objectives.

Basic and applied research to increase the versatility, reliability and safety of aircraft systems, particularly the landing gear systems, is a significant step in this direction. The great challenge is to improve the systems efficiency without compromising safety.

Jet fuel accounts for over 50% of airline operating costs. The results of the commercial aircraft fuel savings program using high-resolution and near real-time winds and temperatures during cruise showed 2-3% fuel savings potential over the North Atlantic. Follow-on research will develop the necessary software (MCIDAS) to retain fine scale features of the atmosphere. This will be accomplished by combining complementary data from weather prediction models, satellites, pilot reports, INS equipped aircraft and radiosondes to retain important subsynoptic scale features.

SPECIFIC OBJECTIVE

TITLE: Operating Systems

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Lee D. Goolsby

SPECIFIC OBJECTIVE:

To define functional requirements and performance criteria for flight systems and displays of the future with which the pilot can safely and effectively operate in the evolving National Airspace System; to perform more efficient flight with respect to fuel, airspace, and time; to increase traffic flow capacity; and to improve the operational capability in adverse weather.

- Investigate concepts to improve exchange of information between ATC and aircraft throughout the flight profile.
- Identify and promote incorporation of aircraft capabilities in design of ATC improvements to facilitate efficient operations.
- Propose and investigate concepts offering improvements to flight deck design, ATC and aircraft systems, and procedures providing more efficient operations.
- Propose and investigate strategies for optimization of terminal-area air traffic flow.
- Develop improved takeoff, approach and landing capabilities.

TARGETS:

- Complete cooperative program with FAA in Microwave Landing System (MLS) Service Test and Evaluation Program (STEP) and complex path display research - FY 1983
- Conduct initial experiments using Mission Oriented Terminal Area Simulator (MOTAS) - FY 1983

- o Complete initial task under joint program with FAA on Integrated Flow Management - FY 1983
- o Complete evaluation of Runway Turnoff Guidance System - FY 1983
- o Complete refitting of experimental avionics system in B-737 aircraft and simulator with reliable state-of-the-art elements - FY 1984
- o Complete joint activities with FAA on Integrated Flow Management - FY 1986

JUSTIFICATION:

This program supports urgently needed research in airplane systems that interface with other elements of the National Airspace System. The capabilities of the airplane systems and their constraints are factors which must be considered in the design of the air traffic control system. Understanding of these capabilities and constraints, their significance and acceptance in promoting safe, conflict-free fuel-efficient flight depends upon thorough analysis and validations, which are major thrusts of this program, that bridge the gap between requirements that can be satisfied solely through ground facilities and those best satisfied by the airplane. Unless this work (development of cooperative ATC/aircraft systems) is done in a timely manner, the inherent benefits of new aircraft potential in safety and fuel conservation could be jeopardized.

SPECIFIC OBJECTIVE

TITLE: Configuration /Propulsion-Airframe Integration

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Raymond S. Rose

SPECIFIC OBJECTIVE:

To provide the advanced technology base, design methodology, and analytical codes for subsonic aircraft to improve safety and efficiency, lower cost, and reduce integration losses that are associated with integrating propulsion systems with the airframe.

- o Perform analysis, wind-tunnel and flight testing of low-drag natural laminar flow (NLF) airfoils and wings.
- o Provide improved procedures and design data for conventional and unconventional aircraft configurations, and develop techniques for aerodynamic configuration drag reduction.
- o Generate basic experimental data and theoretical analyses for high-lift systems and controls.
- o Develop techniques for design of improved stall/spin characteristics.
- o Develop and verify 2D and 3D viscous codes to allow analysis and optimization of propulsion system and airframe integration.

TARGETS:

- o Develop data base for advanced commuter/general aviation aircraft configurations, including parametric variations such as canard, tail and engine locations, and forward and aft swept wings - FY 1983
- o Develop advanced panel method to generate a velocity gradient derivative matrix approach for design of high-lift wing fuselage configurations - FY 1983

- o Develop and verify generic 3D viscous analyses for nacelle/pylon/wing interactions for subsonic aircraft - FY 1983
- o Conduct wind-tunnel and flight tests to develop design constraints for the application of NLF wings in aircraft design - FY 1984
- o Develop generic 3D viscous analysis for nacelle/fuselage interactions for subsonic aircraft - FY 1984
- o Provide spin-resistant design criteria for single-engine aircraft - FY 1985
- o Develop propeller/wing interaction code - FY 1986

JUSTIFICATION:

The recent emphasis on small commuter transport aircraft and general aviation for business and transportation has increased the need for important technological improvements related to aerodynamics and flight dynamics, including increased safety, increased efficiency and greater utility.

For increased safety, a better understanding of underlying aerodynamic design features is needed to achieve stall/spin resistance and/or recovery and to improve control and handling qualities. For greater fuel efficiency, aerodynamic drag of all types must be reduced. The interference between propulsion and airframe components contributessignificantly to aircraft drag, and reductions in interference drag can be realized through experimental and analytical development of configuration design and analysis methods.

SPECIFIC OBJECTIVE

TITLE: Structural Integration

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Havard A. Wood

SPECIFIC OBJECTIVE:

To develop a composites design and analysis data base and structural qualification procedures for safety-of-flight, strength-critical advanced composite structure.

- o Establish advanced composite wing preliminary designs and critical technology issues.
- o Develop design, analysis, and test methodology for moderately loaded composite structure.
- o Develop advanced composite fuselage preliminary designs and critical technology issues.
- o Investigate advanced configurations affected by smooth surface conditions, aeroelastic tailoring, and toughened matrix systems.

TARGETS:

- o Complete composite wing preliminary designs and identify critical technology problems - FY 1983
- o Complete design verification tests of moderately loaded structure - FY 1984
- o Complete composite fuselage preliminary designs and identify critical technology problems - FY 1985
- o Complete composite advanced configuration conceptual designs - FY 1987

JUSTIFICATION:

While composite primary structure can provide 10-15% reduced aircraft gross weights, a comprehensive data base is required to assure that both technical and financial risks are acceptable before incorporating these materials into safety-of-flight structure. The present data base for lightly loaded, stiffness-critical composite structure is totally inadequate for strength-critical, heavily loaded wing and fuselage structure. The data base needed will not only provide design, analysis, fabrication, and testing information to the designer, but it will also provide the structural evaluation methods and procedures required by the military and the FAA for structural qualification and aircraft certification.

SPECIFIC OBJECTIVE

TITLE: Laminar Flow Integration

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Lee D. Goolsby

SPECIFIC OBJECTIVE:

To develop and demonstrate practical, reliable, and maintainable laminar flow technology for application to future civil/military aircraft.

- o Demonstrate performance of laminar flow advanced airfoil concepts at transonic conditions.
- o Demonstrate effectiveness of leading-edge systems to maintain laminar flow under representative flight conditions.
- o Design and evaluate integral and glove surface panel structural concepts.
- o Provide flight data base for NLF, HLFC, and LFC transition analyses/designs.
- o Complete aerodynamic design of laminar flow wing.

TARGETS:

- o Begin leading-edge systems flight tests - FY 1983
- o Complete leading-edge systems flight tests - FY 1984
- o Conduct variable sweep flight tests - FY 1985

JUSTIFICATION:

At typical cruise speeds of transport aircraft, about half the engine power needed to maintain level flight is required to overcome the turbulent friction drag on the external aircraft surfaces. The technical feasibility of preventing the transition of the

boundary layer from laminar to a turbulent state (with the associated large increase in frictional force) has been demonstrated in a laboratory-type environment; however, previous work was terminated before full operational practicability in a realistic environment and the economic feasibility were established. This program exploits recent advances in materials, structures, and aerodynamics to allay industry concerns. The benefit potential is large; the technology is difficult and requires demonstration of practicality; and the technology development is unlikely to occur in a timely manner without NASA effort.

SPECIFIC OBJECTIVE

TITLE: Systems Integration

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Don L. Maiden

SPECIFIC OBJECTIVE:

To exploit the potential benefits to be derived from the systems integration of advanced electric power, active controls and digital electronic technologies for aerospace application.

TARGETS:

- Complete advanced technology assessment and R&T Base coordination plan - FY 1983
- Develop advocacy package for FY 1984 New Initiative entitled Integrated Digital/Electric Aircraft (IDEA) - FY 198:
- Initiate IDEA new initiative - FY 1984

JUSTIFICATION:

NASA sponsored studies have shown a potential 5-10% reduction in the direct operating cost of a conventional transport through the integrated application of advanced electric secondary power systems, active controls and digital electronics. These same studies also indicate significantly reduced maintenance costs. The benefits from this technology would also mean lower life-cycle costs in the procurement and operation of military aircraft. This RTOP will provide the framework for an OAST-coordinated and -managed program to unite fragmented studies and technology efforts in space, as well as aeronautics activities both in NASA and industry, and to focus on the systems characteristics and requirements.

SPECIFIC OBJECTIVE

TITLE: Research Airport Support

Program/Discipline Objective Title: Subsonic Aircraft R&T

Responsible Organization/Individual: Aeronautical Systems Division/Lee D. Goolsby

SPECIFIC OBJECTIVE:

To provide support costs associated with aeronautics programs that use the facilities of the Wallops research airport and other supporting services.

- o Program aircraft ground servicing
- o Control tower management of the Wallops airport area
- o Shop support
- O Search and rescue
- o Chase and other aircraft flight services
- o Crash, fire, and rescue services
- o Specialized instrumentation
- o ADP operations

TARGETS:

- o Annual support to OAST activity at the Wallops research airport.

JUSTIFICATION:

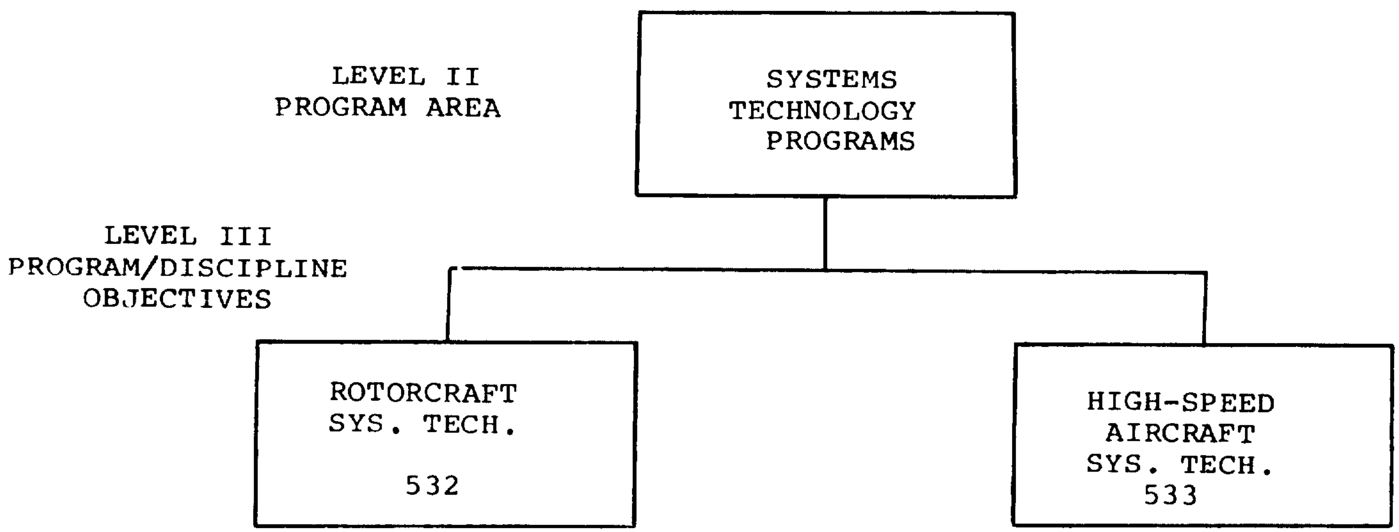
The Wallops Flight Center operates an airport primarily to support aeronautical research and development in those areas dealing with flight characteristics and performance and related aircraft systems. The airport has all essential equipment found at both civilian and military airports. In addition, the airport has experimental and special

purpose facilities including a grooved runway, a wind data system, a project control center, a telemetry and tracking system complex, a flight display facility, a microwave landing system, an angled high-speed runway turnoff, landing guidance system simulation, noise range for flyover noise research, data link connecting Langley and Wallops facilities, arresting gear, and ordnance loading sites for loading rockets on aircraft. The airport and its specialized instrumentation provide vital support to OAST aeronautics projects assigned to Langley which require flight experiments, aeronautics RTOP's assigned directly to WFC, FAA flight research associated with the one-of-a-kind MLS, joint NASA/FAA projects, and some support directly to the Navy.

SYSTEMS TECHNOLOGY PROGRAMS

14

SYSTEMS TECHNOLOGY PROGRAMS WORK BREAKDOWN STRUCTURE
LEVELS II & III



PROGRAM AREA GOAL

TITLE: Systems Technology Programs

Program Goal Title: Aeronautics Research and Technology

PROGRAM AREA GOAL:

To provide technology for systems which have matured under the Research and Technology Base; to carry innovative systems through experimental testing and verification in a realistic environment; to design, fabricate and test multidisciplinary concepts, thereby greatly reducing the technical and development risks and decreasing the excessive time lag between technology development and its application; and to design and fabricate major aeronautical research vehicles which serve as testbeds for evaluating innovative subsystem concepts.

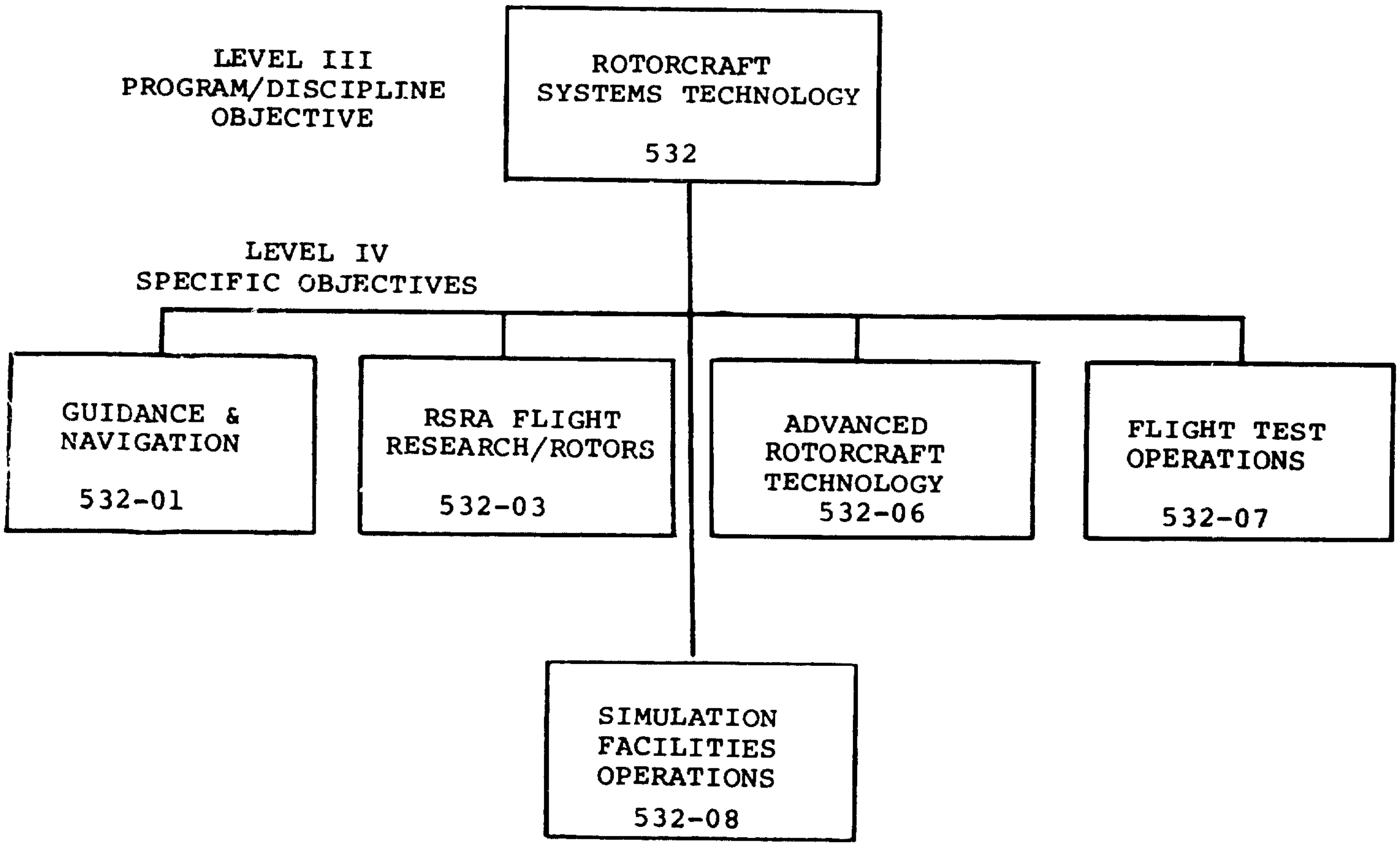
PROGRAM/DISCIPLINE OBJECTIVES:

- Rotorcraft Systems Technology: To advance and to accelerate the transfer of technology for military and civil aircraft.
- High-Speed Aircraft Systems Technology: To perform required research, using ground-based simulators, wind tunnels, and flight tests, to generate engineering and design data necessary to advance high-performance aircraft for civil and military applications.

ROTORCRAFT SYSTEMS TECHNOLOGY

ROTORCRAFT SYSTEMS TECHNOLOGY

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: Rotorcraft Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Aeronautical Systems Division/John F. Ward

PROGRAM/DISCIPLINE OBJECTIVE:

To advance and to accelerate the transfer of technology for military and civil rotorcraft.

SPECIFIC OBJECTIVES:

- Guidance and Navigation: To provide the technology for innovative navigation, guidance, flight control, and display systems, and operating techniques that will afford rotorcraft the capability of safely, quietly, and efficiently making steep, slow, and even spiraling Visual Flight Rules (VFR) type approaches to a small remote landing site under Instrument Flight Rules (IFR) and nighttime conditions.

- RSRA Flight Research/Rotors: To validate rotor systems technology for future military and civil designs through system investigations, methodology improvement, and support of generic tests in flight on the Rotor Systems Research Aircraft. Such generic research documents the behavior of current and advanced rotor systems and identifies problem areas and design requirements. To conduct systematic variation of rotor parameters to form the basis for improvements in performance, blade dynamics, loads, stability, and control. To increase the understanding of rotor systems through pre- and post-test analytical methodology.

- Advanced Rotorcraft Technology: To provide the technology for the low-risk design of advanced military and civil rotorcraft systems and subcomponents based on verified design tools and experimental methods with emphasis on rotor and rotor/airframe detailed aerodynamic and aeroelastic prediction for control of vibration and noise; advanced materials application; advanced all-weather guidance, navigation and control systems concepts; advanced propulsion systems; and advanced vehicle concepts which have significant potential gains in productivity. The activity

involves focused and coordinated research in analysis, model and large-scale ground testing, and flight testing. This program encompasses civil and military roles for advanced rotorcraft.

- Flight Test Operations: To provide support for Ames research aircraft flight experiments in low-speed aerodynamics, flight dynamics and control, guidance and navigation, and avionics systems for advanced military and civil rotorcraft, V/STOL aircraft, and STOL aircraft.

- Simulation Facilities Operations: To provide support of flight simulation programs in guidance, navigation, control, and handling qualities of these classes of aircraft for the low-speed flight regime of other classes of aircraft.

SPECIFIC OBJECTIVE

TITLE: Guidance and Navigation

Program/Discipline Objective Title: Rotorcraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Jeffrey H. Godfrey

SPECIFIC OBJECTIVE:

To provide the technology for innovative navigation, guidance, flight control, display systems, and operating techniques that will afford rotorcraft the capability of safely, quietly, and efficiently making steep, slow, and even spiraling VFR-type approaches to a small remote landing site under IFR and nighttime conditions. This objective encompasses military and civil roles for rotorcraft with emphasis on:

- Improving safety,
- Increasing vehicle productivity,
- Expanding mission capability,
- Increasing fuel efficiency through operation techniques,
- Reducing pilot workload, and
- Optimizing flight profiles for low community noise operation,

with identification of the impact of deficiencies of basic aircraft stability, control and handling qualities.

TARGETS:

- Develop crew-station design criteria for advanced day/night all-weather integrated guidance and control concepts.

  - Complete development of rotorcraft simulation facility for crew-station design criteria - ARC, FY 1984.

- Develop design criteria and crew performance tradeoffs for remote-site guidance concepts.

  - Complete evaluation of commercial weather radar

as on-board guidance and landing system for remote land and water sites - ARC, FY 1985.

- Define operational and performance limitations of MLS curved, segmented, and decelerating rotorcraft approaches.

  - Complete joint NASA/FAA full-capability MLS flight test - ARC, FY 1985.

  - Complete definition of effects of adverse weather extremes on rotorcraft instrument meteorological conditions (IMC) approaches - ARC, FY 1985.

JUSTIFICATION:

Tomorrow's rotorcraft will fulfill their role in enhancing the U.S. total air transportation capability and military effectiveness only if they have full day/night all-weather capabilities. All-weather rotorcraft operations are currently quite limited. Although some helicopters, especially in the military, are being flown today under IFR conditions, the equipment and techniques used are basically spinoffs from conventional take-off-and-landing (CTOL) applications. Rotorcraft have not taken advantage of new technology such as programmable computers to perform multi-system tasks, electronic displays, time-sharing data transmission, and strapdown inertial measurement units which could provide low cost, improved reliability, and increased capability.

SPECIFIC OBJECTIVE

TITLE: RSRA Flight Research/Rotors

Program/Discipline Objective Title: Rotorcraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Donald L. Maiden

SPECIFIC OBJECTIVE:

To validate rotor systems technology for future military and civil designs through system investigations, methodology improvement, and support of generic tests in flight on the Rotor Systems Research Aircraft. Such generic research documents the behavior of current and advanced rotor systems and identifies problem areas and design requirements. To conduct systematic variation of rotor parameters to form the basis for improvements in performance, blade dynamics, loads, stability, and control. To increase the understanding of rotor systems through pre- and post-test analytical methodology.

- o Expand the data base ground-based testing of rotors of opportunit and on a family of new blades and hubs hav g systematic variations in aerodynamic and structural design parameters.
- o Where indicated, expand the flight data base on existing rotors that may become available from other programs, which can be readily adapted for the detailed evaluation available through RSRA testing.
- o Operate the two RSRA and maintain and improve their capability as a national flight test facility.

TARGETS:

- o Test a Bearlingless Main Rotor (second entry) in t e full-scale wind tunnel to provide an expanded data base of the dynamic characteristics for several configuration changes - ARC, FY 1983.
- o Complete the comprehensive documentation of the RSRA (helicopter) with the S-61 rotor - ARC, FY 1983.

- o Provide general operating support for the two RSRA, including ground support equipment, to conduct specific tests on vibration, noise, aerodynamic interference, stability and control augmentation systems, and multi-cyclic control - ARC, FY 1983.

- o Test an existing modern helicopter rotor in model and full-scale at high speed to measure performance, loads, blade dynamics, and static stability and control - ARC, FY 1984.

- o Complete the installation and checkout of a modern helicopter rotor on the RSRA (helicopter) - ARC, FY 1984.

JUSTIFICATION:

R&T Base programs in such disciplinary areas as aerodynamics, acoustics, structural dynamics, handling qualities, materials, and structural design are of first-order importance in building the technology base for potential dramatic advancements in rotor systems. However, the technology disciplines are so interwoven in the rotor system dynamic environment that a broad-based systems technology program approach addressing rotor systems as entities is mandatory.

Some projected advanced rotor systems benefits are a 20-percent increase in payload, 10-percent increase in blockspeed, 10-PNdB reduction in noise, 10-percent reduction in fuel use, and 50-percent reduction in vibration and associated maintenance. These goals can only be achieved, however, through fully coordinated systems and engineering design studies, extensive interdisciplinary experimental and analytical technology investigations using ground-based facilities, and carefully selected generic flight experiments using sophisticated research aircraft such as RSRA.

SPECIFIC OBJECTIVE

TITLE: Advanced Rotorcraft Technology

Program/Discipline Objective Title: Rotorcraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/George Unger

SPECIFIC OBJECTIVE:

To provide the technology for the low-risk design of advanced military and civil rotorcraft systems and subcomponents based on verified design tools and experimental methods with emphasis on rotor and rotor/airframe detailed aerodynamic and aero-elastic prediction for control of vibration and noise; advanced materials application; advanced all-weather guidance, navigation and control systems concepts; advanced propulsion systems; and advanced vehicle concepts which have significant potential gains in productivity. The activity involves focused and coordinated research in analysis, model and large-scale ground testing, and flight testing. This program encompasses civil and military roles for advanced rotorcraft.

TARGETS:

- o Complete assessment and development of analytical models correlated with shake tests to be used in the design analysis of airframe vibration - LaRC, FY 1983.
- o Complete critical systems research and specific tasks which lead to the testing of a convertible (turbofan/shaft) engine, using the TF-34 - LeRC, FY 1983.
- o Complete the criteria for passenger acceptance of cabin noise and vibration - LaRC, FY 1984.
- o Complete model scale tests of an AH-1G with pressure instrumented blades in the Langley 4x7-meter (V/STOL) tunnel - LaRC, FY 1984.
- o Complete a full-scale test in the 40x80-ft. Wind Tunnel to investigate rotor/fuselage/tail rotor aerodynamics and acoustic interference characteristics (Joint Program with RAE) - ARC, FY 1984.

- o Complete analysis of loop multi-cyclic control investigations through 40x80-ft. wind-tunnel tests (FY 1983); conduct closed-loop investigations and develop multi-cyclic control concepts for vibration and load reduction - ARC, FY 1984.

- o Complete full-scale wind-tunnel testing of advanced composite blades for the XV-15 - ARC, FY 1985.

- o Complete joint NASA/AHS Noise Program - ARC, LaRC, LeRC, FY 1987.

- o Complete development of advanced composite materials technology for the next generation helicopter air-frame in cooperation with the U.S. Army and industry - LaRC, FY 1987.

JUSTIFICATION:

In order to adequately support the continued growth of civil rotorcraft utilization and the future needs of military rotorcraft designs, a focused systems technology effort is necessary to integrate research advances in aerodynamics, acoustics, structures, materials, avionics, and propulsion so as to advance the technology to meet rotorcraft design opportunities. Key elements of this technology are verified design methods which allow the design of new systems with low risk. In order to achieve this level of design reliability, research must be conducted in a systemmatic fashion which correlates new design analyses with technical data obtained from a series of carefully planned ground and flight tests of advanced hardware systems and subsystems.

SPECIFIC OBJECTIVE

TITLE: Flight Test Operations

Program/Discipline Objective Title: Rotorcraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Donald L. Maiden

SPECIFIC OBJECTIVE:

To provide support for Ames research aircraft flight experiments in low-speed aerodynamics, flight dynamics and control, guidance and navigation, and avionics systems for advanced military and civil rotorcraft, V/STOL aircraft, and STOL aircraft.

TARGETS:

- o Maintain and operate Ames research aircraft safely and efficiently to support scheduled research flight experiments - ongoing.
- o Maintain and operate simulation facilities in support of scheduled research flight simulation programs - ongoing.

JUSTIFICATION:

The Ames Research Center carries out a broad program of analytical and experimental research in aerodynamics, flight dynamics and control, guidance and navigation, and avionics systems with emphasis on advanced rotorcraft, V/STOL, and STOL aircraft. This research is supported by a broad-based technical capability which combines wind-tunnel investigation, flight simulation, and flight evaluation using a variety of special research aircraft. Flight evaluation therefore plays a vital role in this integrated approach and the resulting data is a major factor in the Center's contribution to new technology.

532-08

SPECIFIC OBJECTIVE

TITLE: Simulation Facilities Operations

Program/Discipline Objective Title: Rotorcraft Systems Technology

Responsible Organization/Individual: OAST Office of Facilities/Frank Penaranda

SPECIFIC OBJECITVE:

To provide support of flight simulation programs in guidance, navigation, control, and handling qualities of these classes of aircraft and for the low-speed flight regime of other classes of aircraft.

TARGETS:

- Maintain and operate simulation facilities in support of scheduled research flight simulation programs **(ongoing)**

JUSTIFICATION:

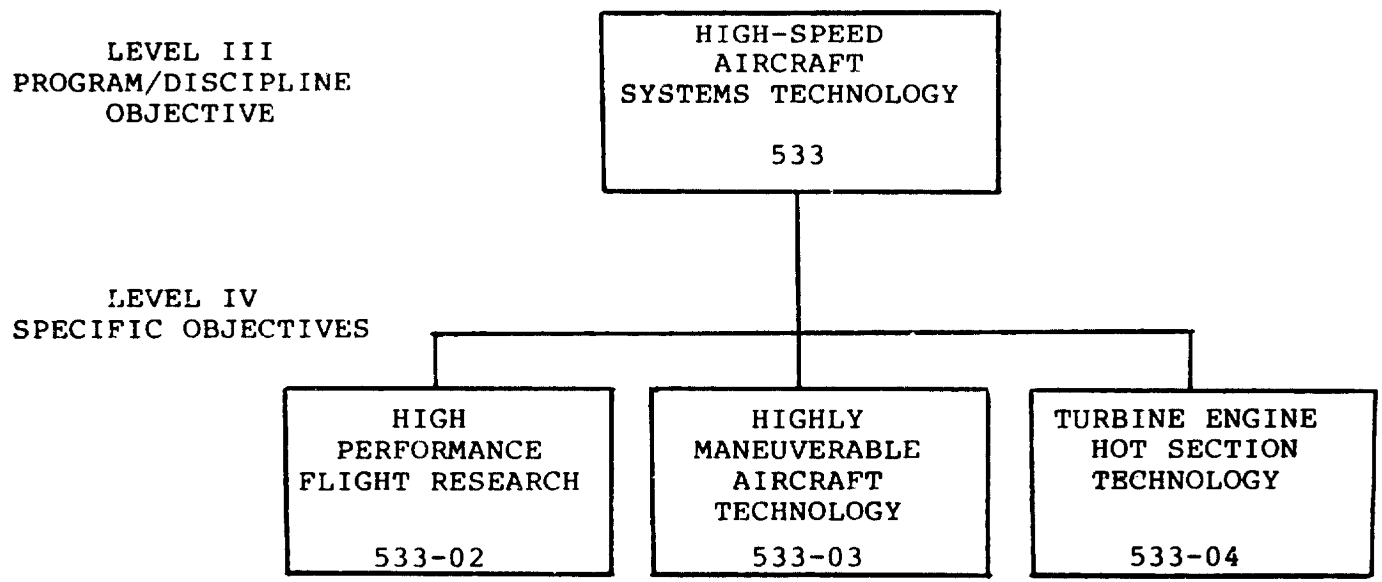
The Ames Research Center carries out a broad program of analytical and experimental research in aerodynamics, flight dynamics and control, guidance and navigation, and avionics systems with emphasis on advanced rotorcraft, V/STOL, and STOL aircraft. This research is supported by a broad-based technical capability which combines wind-tunnel investigation, flight simulation, and flight evaluation using a variety of special research aircraft. Flight simulation therefore plays a vital role in this integrated approach and the resulting data is a major factor in the Center's contribution to new technology.

HIGH-SPEED AIRCRAFT SYSTEMS TECHNOLOGY

16

HIGH SPEED AIRCRAFT SYSTEMS TECHNOLOGY
WORK BREAKDOWN STRUCTURE

LEVELS III & IV



PROGRAM/DISCIPLINE OBJECTIVE

TITLE: High-Speed Aircraft Systems Technology

Program Area Title: Systems Technology Programs

Responsible Organization/Individual: Aeronautical Systems Division/Jack Levine

PROGRAM/DISCIPLINE OBJECTIVE:

To perform required research, using ground-based simulators, wind tunnels, and flight tests, to generate engineering and design data necessary to advance high-performance aircraft for civil and military applications.

- o High Performance Flight Research: To conduct analyses, tests, and selected flight experiments using high-speed aircraft as necessary to explore and evaluate advanced technologies.

- o Highly Maneuverable Aircraft Technology (HiMAT): To promote and stimulate the application of new (high-risk) technology in a multidisciplinary manner so as to exploit, to the highest practical degree, the synergistic potential of new technology for the design of future fighter aircraft; and to provide verification of the cost-effectiveness and technology transition efficiency of using the remotely-piloted research vehicle (RPRV) concept for conducting flight research, especially on advanced high-risk concepts.

- o Turbine Engine Hot Section Technology (HOST): To develop analytical models and predictive tools for the durability and life assurance design of hot section components of advanced aircraft turbine engines.

SPECIFIC OBJECTIVE

TITLE: High Performance Flight Research

Program/Discipline Objective Title: High-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Jack Levine

SPECIFIC OBJECTIVE:

To conduct analyses, tests and selected flight experiments using high-speed aircraft as necessary to explore and evaluate advanced technologies.

- AFTI: Conduct analyses and tests on the joint Air Force/NASA AFTI Program consisting of two major elements: AFTI/F-111 Mission Adaptive Wing and AFTI/F-16.
  - Verify in the real and dynamic world of flight, the predicted performance gains for the AFTI/F-111 Mission Adaptive Wing.
  - Verify the performance of active controls for load alleviation and reduced static stability incorporated in the AFTI/F-111 Mission Adaptive Wing aircraft.
  - Determine the pilot-vehicle interaction and limits of control provided by the AFTI/F-16 direct force control over the aircraft's flight envelope.
  - Evaluate the utility of the AFTI/F-16 multi-variable digital flight control system for a modern high-performance fighter.
- Advanced Fighter Aircraft Technology: Perform flight research and related ground facilities supporting research and support Department of Defense agencies on new aerodynamic, propulsion, flight dynamics or other technologies using available high-performance military aircraft.
  - Conduct tests to determine the effects of spanwise blowing on performance, maneuverability and flight dynamics characteristics using an F-4C aircraft.

- Conduct tests to evaluate the flight performance of an F-100 Advanced Derivative Engine using an F-15 aircraft.

o Decoupler Pylon (F-16): Design, fabricate and flight test a NASA-developed decoupler pylon to assess the performance improvements and alleviation of the stores flutter problem and evaluate the dynamic characteristics of the device.

- Assess aircraft performance improvements achievable by using the decoupler pylon as a stores-carrying device.

- Determine the increase in flutter speeds associated with using the pylon.

- Evaluate the pylon's response to the dynamic maneuvers and characteristics obtained in flight.

o Forward Swept Wing: Conduct analyses, wind tunnel tests, simulations, ground facilities tests and flight tests in order to discharge responsibilities established in the NASA/DARPA Memorandum of Agreement concerning the Forward Swept Wing Flight Demonstration Program.

- Provide technical advisory support during the development and acquisition of the FSW flight demonstration vehicles.

- Perform wind-tunnel tests of DARPA/contractor models in NASA facilities.

- Perform special ground facilities tests and simulations to help understand basic aerodynamic/structural/control system/handling qualities aspects of the FSW flight demonstration vehicles.

- Conduct the Government flight tests of the FSW flight demonstration vehicles.

o Powered-Lift Systems Technology: Obtain data through flight and ground-based research on propulsive-lift aircraft and define criteria for flying qualities, control system design and IMC guidance and navigation for future powered lift aircraft.

- Determine for flight operation at high lift, the requirements and criteria for takeoff and approach, performance, stability and control, handling qualities, operational safety margins, and noise certification data. (QSRA)

- Establish guidance, navigation, control system, and air traffic control interface requirements for short-haul transports. (QSRA)

- Validate ground-based simulation and perform inflight simulation of advanced design concepts for V/STOL aircraft. (YAV-8B)

- Develop and demonstrate advanced flight control systems and IMC guidance and navigation systems with the Harrier. (YAV-8B)

o INTERACT: Perform flight research and related ground facilities supporting research to advance the technology essential for achieving integrated airframe/propulsion control systems in advanced high-speed aircraft.

  - Conduct studies of potential flight implementation options considering current and near-term high-performance military aircraft.

  - Develop flight hardware/software needed to implement the selected option for performing flight research related to integrated airframe/propulsion control systems.

  - Perform required wind-tunnel, simulation or other ground facilities tests to support the selected flight implementation program.

  - Conduct flight tests and analyze the results relative to analytical/simulator predictions.

o Advanced Aircraft Projects: (CLASSIFIED)

o Flight Support: Provide support and operations of the support aircraft at Ames Research Center's Dryden Flight Research Facility.

  - Provide flight support to remotely-piloted research vehicles such as HiMAT and Drones for Aerodynamic and Structures Testing (DAST).

- Provide flight support for high-performance manned vehicle flight programs such as the F-14 High Angle-of-Attack Testing, AFTI F-111 Mission Adaptive Wing Technology, and AFTI F-16 Envelope Expansion Tests.

- Provide flight support for other research programs such as Jetstar Turboprop Tests, Wake Vortex Minimization, F-8 Digital Fly-By-Wire, and AD-1 Oblique Wing Tests.

TARGETS:

o (AFTI/F-111) Mission Adaptive Wing (MAW)

  - Complete development and test of manual flight control evaluation in FY 1983.

  - Complete evaluation of manual flight control system in FY 1984.

  - Complete flight research activities in FY 1985.

o (AFTI/F-16)

  - Complete Digital Flight Control System (DFCS) Phase I evaluation in FY 1983.

  - Complete Automatic Maneuvering Attack System (AMAS) in FY 1984.

  - Complete flight research activities in FY 1985.

o Advanced Fighter Aircraft Technology

  - Complete, in FY 1983, flight tests of an F-100 Advanced Derivative Engine in an F-15 aircraft.

  - Complete, by FY 1985, flight research and related ground facilities supporting research related to determining the effects of spanwise blowing on the flight characteristics of an F-4C aircraft.

o Decoupler Pylon (F-16)

  - Complete fabrication and system checkout of two decoupler pylons in FY 1983.

  - Complete Decoupler Pylon/F-16 ground test in FY 1984.

  - Complete flight program - FY 1985.

- o Forward Swept Wing

  - Complete, in FY 1983, high angle-of-attack wind-tunnel tests and Differential Maneuvering Simulator tests.

  - Complete, by FY 1984, takeoff and approach and landing ground-based motion simulations.

  - Complete, by FY 1984, rigid body/aeroelastic/ control system interactions analyses and testing in the Transonic Dynamics Tunnel.

  - Complete, by FY 1986, initial Government flight tests and limited angle of attack envelope expansion.

- o Powered Lift Systems Technology

  - Complete input to development of STOL handling qualities certification criteria - FY 1983.

  - Complete operation systems flight experiments - FY 1983

  Delays in initiation of flight program due to support of DOD programs and funding limitations change target to FY 1984 for complete element.

- Flight Dynamics	FY 1983
- Certification Criteria	FY 1984
- Fuel Efficient Guidance	FY 1984

  - YAV-8B to be delivered to ARC in late FY 1983.

  - Data acquisition system development for Harrier to be completed in FY 1983. (ARC)

  - Operational checkout of Harrier - FY 1984.

  - Simulation math model validation - FY 1985.

  - Define criteria for flying qualities, control system design, IMC guidance and navigation for future powered-lift aircraft - FY 1986.

  - Validation by extensive ground based and inflight simulation of Harrier - FY 1987.

- o INTERACT

  - Complete, in FY 1983, potential flight implementation options studies.

- Initiate, in FY 1983, the development of the flight hardware/software system.

- Initiate, by FY 1986, flight research on integrated airframe/propulsion control systems technology.

o Advanced Aircraft Projects: (CLASSIFIED)

o Flight Support

- Support, during FY 1983, flight research programs and experiments.

JUSTIFICATION:

o AFTI:

- Mission Adaptive Wing (AFTI/F-111): NASA's portion of this joint NASA/Air Force program is to conduct the wind-tunnel testing necessary to support the program and develop the basic performance predictions, as well as to conduct the necessary flight research activities. The Air Force will provide the mission adaptive wing installed on a suitably modified test F-111 aircraft.

  The program will provide validation of the variable camber and active control technology options for future military aircraft designs. The program directly supports the NASA objective to provide advanced technology to support military needs.

- AFTI/F-16: NASA's portion of the joint NASA/Air Force program is to conduct the wind-tunnel testing necessary to support the program and develop the basic performance predictions. This portion of the activity has been completed. Subsequent to the Air Force providing the modified aircraft in FY 1982, NASA will conduct the flight research activities on the vehicle. The program will provide validated technology options in flight control for future military aircraft. The program directly supports the NASA objective to provide advanced technology to support military needs.

o Advanced Fighter Aircraft Technology: The potential improvements in aircraft maneuvering performance at subsonic and transonic speeds from spanwise blowing have been investigated in wind-tunnel

studies and limited flight tests. Optimum spanwise blowing system parameters, blowing locations and other factors have not been thoroughly studied, and adequate correlations between "real world" flight behavior and predictions from ground facilities tests have not been made. This program will produce validated technical data on spanwise blowing and will provide another potential option for incorporation in future advanced military aircraft.

The Air Force has requested NASA assistance and support in flight testing the F-100 Advanced Derivative Engine. This engine is designed to provide higher thrust and is being considered for the F-14, F-15, and F-16 aircraft. NASA's intimacy with the F-15 aircraft and the successful conduct of the Digital Electronic Engine Control program on this aircraft/engine combination makes NASA very qualified to support the Air Force on this program.

o Decoupler Pylon (F-16): NASA has developed and evaluated in the wind tunnel, a decoupler pylon which dynamically isolates the pylon and wing. This pylon has shown in wind-tunnel tests that large decreases in stores-flutter penalties are possible with its use. This program will validate the ground-based results in the real and dynamic world of flight.

The program will provide validated technology options for future military aircraft. The program directly supports the NASA objective to provide advanced technology to support military needs.

o Forward Swept Wing: In April 1981, NASA and DARPA signed a Memorandum of Agreement which established specific NASA and DARPA responsibilities in the conduct of the Forward Swept Wing Flight Demonstrator Program. The MOA states that NASA will provide assistance to DARPA and its technical agent during the final design, fabrication, ground testing, and functional flight testing of the flight vehicles, and also that NASA will be responsible for the overall technical and operational portions of the Government-conducted flight tests. In order to meet its obligations and to help ensure maximum technical

output from the Government-conducted flight tests, NASA must perform analyses, wind-tunnel tests, simulations and other ground facilities tests using its unique capabilities and must give high priority, both prior to and after delivery of the demonstrator aircraft, to all aspects of flight testing the forward-swept-wing vehicles.

- Powered-Lift Systems Technology: Propulsive-lift technology is needed by Government and Industry to develop options for future U.S. civil and military short-haul transports and fighter aircraft. Commercial, domestic, and foreign markets require these data, due to the projected increase in air travel and limitation of airport acquisition for cost, congestion and environmental reasons. Also improvement in military tactical airlift capability demands improvement in this technology. Regulatory agencies require this information so that environmental and certification criteria can be established.

  Seabasing, wide dispersal of forces, runway denial and improvement of maneuverability are factors that drive future military requirements toward V/STOL aircraft. This technology is intended to address these needs.

- INTERACT: Most current high-speed aircraft have essentially no coupling or integration of airframe and propulsion control functions, and the historic separate development of airframe control systems and engine control systems has been reasonably logical. For high-performance military aircraft, the development of variable inlet control systems, uncoupled from the airframe control systems, has been under the cognizance of the airframe manufacturer, although the engine manufacturer has maintained cognizance of the variable area symmetric nozzle control function. For most future high-speed aircraft concepts, this overall situation will change dramatically, and coupling/integration of airframe and propulsion control functions will be essential. One of the key unknowns is how to implement integrated airframe/propulsion control functions so as to permit the pilot to achieve maximum aircraft combat or mission effectiveness. Flight research in the "real world" environment is essential to advance the technology with regard to this key unknown.

- Advanced Aircraft Projects: (CLASSIFIED)

- Flight Support: Flight research programs and experiments at the Ames Research Center/Dryden Flight Research Facility require readiness training and chase/drop/communications aircraft support to adequately carry out safe, efficient, high-quality research. The work done under this specific objective provides that flight research support.

SPECIFIC OBJECTIVE

TITLE: Highly Maneuverable Aircraft Technology (HiMAT)

Program/Discipline Objective Title: High-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aeronautical Systems Division/Jack Levine and Ming Tang

SPECIFIC OBJECTIVE:

To promote and stimulate the application of new (high-risk) technology in a multidisciplinary manner so as to exploit, tc the highest practical degree, the synergistic potential of new technology for the design of future fighter aircraft; and to provide verification of the cost-effectiveness and technology transition efficiency of using the remotely-piloted research vehicle (RPRV) concept for conducting research, especially on advanced high-risk concepts.

- o Validate advanced aerodynamic technology and advanced design techniques.
- o Demonstrate the benefits of an all-composite aeroelastically tailored wing.
- o Verify operational concepts associated with the use of advanced RPRV configurations.

TARGETS:

- o Demonstrate the supersonic design condition and the transonic design condition with reduced static stability during FY 1983.
- o Verify an increase of 100% in aerodynamic efficiency over current vehicles by use of an advanced wing/canard configuration employing aeroelastic tailoring by end of FY 1983.
- o Complete the acquisition of the detailed flight research data relative to the advanced technologies incorporated in the HiMAT vehicles - FY 1983.

JUSTIFICATION:

In discharging its statute responsibility, NASA conducts aeronautical research and testing of experimental aircraft as required to support military and civil aviation objectives. In contrast with

NASA's emphasis on research and basic technology, the military services must place emphasis on applied research and systems development. The instrument of coordination of the aeronautics program activity and interchange of information between the Services and NASA is the DOD/NASA Aeronautics and Astronautics Coordinating Board (AACB).

The Joint NASA/Air Force HiMAT/RPRV program is in direct response to the recommendations of the AACB developed by its Aeronautics Panel in a special study of research needs (November 1972) which found that "substantial improvements in maneuver capability will be needed for advanced fighters in the 1980's" and suggested that the opportunity to conduct flight research at low cost offered by RPRV's be exploited to bring new technologies to a state of application readiness.

SPECIFIC OBJECTIVE

TITLE: Turbine Engine Hot Section Technology (HOST)

Program/Discipline Objective Title: High-Speed Aircraft Systems Technology

Responsible Organization/Individual: Aerospace Research Division/Deene J. Weidman

SPECIFIC OBJECTIVE:

To develop analytical models and predictive tools for the durability and life assurance design of hot section components of advanced aircraft turbine engines.

- To establish predictive methods for strength and life determination of hot section components, including material constitutive behavior and structural damage and failure modes.

- To establish predictive methods and test verification of the internal engine environment, including aerodynamic, thermal, and mechanical loadings.

TARGETS:

- Demonstrate, by FY 1984, a high temperature static strain gage measurement system.

- Demonstrate, by FY 1984, heat flux sensors and thin film thermocouples capable of operating in a combustor environment.

- Demonstrate, by FY 1987, combustor liner and vane life predictive methodology on simulated hardware.

JUSTIFICATION:

Engine maintenance cost is a major economic factor in the viability of today's high-performance turbine engines. In 1980, maintenance for aircraft engines was in excess of 400 million dollars. This is expected to increase to 2 billion dollars by 1990 as engine turbine performance is pushed to higher temperatures and pressures for greater fuel economy. There is a great need for the development of technology to design durability into future engine

components. This can only be done after suitable analytical models of the turbine environment have been developed. The trial and error methods of component design of the past are too costly and too unreliable for the future. The objective and scope of this program address this need.